(vi) Aggregate $EPFD_{down}$ limits

103. *Proposal.* In the *NPRM*, we stated our concern about the cumulative effect of multiple NGSO FSS systems on sharing with GSO FSS networks, and sought comment as to how the proposed sharing criteria should be applied or adjusted to account for multiple NGSO FSS systems.[228]

104. *Comments.* Among the commenters, there is general consensus that in order to adequately protect GSO FSS networks in the Ku-band, aggregate NGSO FSS $EPFD_{down}$ limits need to be established.[229] PanAmSat proposes that each NGSO FSS applicant provide a demonstration that it meets the aggregate limits contained in the CPM Report. PanAmSat proposes further that the NGSO FSS operator provide the software and all of the assumptions used for this demonstration to the Commission.[230] SkyBridge asserts that software validation of the aggregate levels is not appropriate.[231] Boeing argues that the Commission should not require the development of software to be used by NGSO FSS licensees to determine whether the combined interference of their system and previously launched NGSO FSS systems would exceed the aggregate mask limitations as PanAmSat suggests. Boeing adds that such software is unnecessary to determine compliance with aggregate mask limitations for the first three NGSO FSS systems launched because if each of the first three NGSO FSS systems can demonstrate compliance with the single entry mask limits, then the combined interference of all three systems cannot exceed the aggregate mask limitation.[232]

105. SkyBridge argues that compliance with the aggregate levels must be assessed on an international level because the aggregate levels are determined by the combined interference stemming from all of the operating NGSO constellations, including constellations that may not be serving the U.S. SkyBridge urges the Commission to allow the development of the WRC-2000 example aggregate resolution to mature.[233] Virgo contends that the CPM Report does not contain any resolution of the question of how Administrations will ensure that the aggregate interference levels from multiple NGSO FSS systems do not exceed the overall protection criteria that have been identified for co-frequency GSO systems.[234] GE asserts that single-entry limits for individual NGSO FSS systems should be capable of being revised if the aggregate limits will be exceeded by the entry of additional NGSO FSS systems.[235] Lockheed asserts that the Commission should make clear in its rules that any NGSO FSS system will be required to participate in any regime that is established to ensure that aggregate interference, limits set forth in the ITU, are not exceeded for multiple systems.[236] Finally, PanAmSat argues that each NGSO

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[228] *NPRM* at ¶¶ 73-74.

[229] *See, e.g.,* Satellite Coalition Comments at 5, Boeing Comments at 52-55, PanAmSat Comments at 13, GE Reply Comments at 4-6, and Telesat Canada Comments at 4.

[230] PanAmSat Supplemental Comments at 17-18.

[231] SkyBridge Supplemental Comments at 21.

[232] Boeing Comments at 4.

[233] SkyBridge Comments on Results of WRC-2000 at 10-11 (filed July 20, 2000). *See* Resolution [COM 5/6] contained in Provisional Final Acts of WRC-2000, which requests the ITU-R to develop a methodology for calculating the aggregate $EPFD_{down}$ levels produced by multiple NGSO FSS systems.

[234] Virgo Supplemental Comments at 4-5.

[235] GE Comments at 9-10 and GE Reply Comments at 2.

[236] Lockheed Supplemental Comments at 10.

FSS applicant should be required to provide, prior to licensing, a demonstration of compliance with the aggregate additional operational limits.[237]

106. *Decision.* We find that the cumulative level of interference from all co-frequency NGSO FSS systems, *i.e.* the aggregate level, is what must be limited. Therefore, we adopt aggregate validation $EPFD_{down}$ limits in addition to the single-entry $EPFD_{down}$ limits. These limits are contained in Section 25.208(e). In fact, the single-entry $EPFD_{down}$ validation limits contained in Section 25.208(d)[238] were derived from these aggregate validation $EPFD_{down}$ limits using the methodology contained in ITU-R Recommendations and assuming a conversion factor of 3.5.[239] We find use of the 3.5 conversion factor is appropriate because it takes into account the way in which interference from multiple systems aggregates into a GSO FSS earth station antenna, recognizing that the interference is not strictly additive in a linear or power sense.

107. Although we agree on the importance of requiring NGSO FSS systems to meet aggregate limits, we see many practical difficulties in actually verifying compliance with aggregate limits of any kind. The ITU-R and WRC-2000 also recognized the difficulties, from a regulatory perspective, of checking compliance with an aggregate level. The difficulties include: (1) varying implementation plans do not allow all the number of or the characteristics of the NGSO FSS systems to be known in advance; (2) foreign licensed systems; (3) measurement of aggregates is not technically possible so it must be done through simulation. In addition, since NGSO to NGSO co-frequency sharing has not been thoroughly studied and NGSO FSS licensing rules have not yet been developed, it is unclear at this point how many and in what sequence the qualified NGSO FSS applicants will be licensed. We will not require a demonstration of NGSO FSS compliance with the aggregate limits at this time. Rather, we will require each NGSO FSS licensee to certify to us that it will meet the limits set out in Section 25.208(e). We note that this issue is the subject of further study within the ITU-R.[240] In the future, as these studies progress, we may require each NGSO FSS applicant to demonstrate its ability to meet the aggregate $EPFD_{down}$ limits contained in Section 25.208(e) of the Commission's Rules. We, therefore, place NGSO FSS applicants on notice that the requirement for such a demonstration will be addressed, as necessary in the NGSO FSS to NGSO FSS rule making or, in the NGSO FSS authorization itself.

108. We believe that the aggregate limits issue also needs to be addressed internationally because NGSO FSS systems can be authorized by multiple Administrations. In fact, the WRC-2000 Resolution[241] on the aggregate issue urges Administrations implementing NGSO FSS systems to take all

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[237] PanAmSat Supplemental Comments at 17.

[238] *See* Appendix A.

[239] The ITU-R agreed that "[a] value of 3.5 for $N_{effective}$ was to be used to determine the final values of single-entry $EPFD_{down}$ versus percentage of time to be applied in bands currently covered under Resolution 130 (WRC-97). This value is to be used solely for the purpose of deriving single-entry $EPFD_{down}$ masks from aggregate $EPFD_{down}$ masks and is not a representation of the actual number of non-GSO FSS systems that can share a given frequency band." *See* Sections 3.1.1.1 and 3.1.1.2 of the CPM Report. This conversion factor does not correspond to the number of NGSO FSS systems that can be accommodated due to the different NGSO FSS constellations proposed.

[240] *See* Resolution COM 5/6 from the Provisional Final Acts of WRC-2000 entitled "Protection of GSO FSS and GSO BSS Networks from the Maximum Aggregate Equivalent Power Flux-Density Produced by Multiple NGSO FSS Systems in Frequency Bands where EPFD Limits Have Been Adopted." This Resolution calls for study of "a suitable methodology for calculating the aggregate EPFD produced by all NGSO FSS systems."

[241] *Id.*

possible steps to ensure that the aggregate $EPFD_{down}$ limits are not exceeded. The United States intends to work with other Administrations to uphold the principles articulated in the WRC-2000 Resolution. We note, however, that there was no international agreement on the need for aggregate additional operational limits to protect GSO FSS operations. Given our adoption of single-entry validation, operational, additional operational, and aggregate $EPFD_{down}$ limits, we find it is not necessary to also adopt aggregate additional operational $EPFD_{down}$ limits, as suggested by PanAmSat.

e. Other Issues

(i) Provision of Ancillary Mobile Services in the Ku-Band

109. Qualcomm Incorporated ("Qualcomm") asserts that the $EPFD_{down}$ limits adopted in this proceeding should protect its incumbent mobile earth stations. Qualcomm is authorized as a non-conforming user to operate mobile satellite earth terminals that receive signals from GSO FSS satellites in the 11.7-12.2 GHz band and transmit signals to GSO FSS satellites on a secondary basis in the 14.0-14.5 GHz band. Qualcomm, however, argues that it should be treated as an incumbent, primary Ku-band GSO service provider for purposes of sharing analysis.[242] Qualcomm claims that its mobile antennas have a gain pattern dramatically different from the rotationally symmetric patterns typically used in NGSO to GSO sharing analyses. To protect its mobile-satellite receive earth station operations, Qualcomm proposes an $EPFD_{down}$ limit of -153.8 dBW/m^2/4kHz (which is equivalent to -143.8 dBW/m^2/40 kHz) never to be exceeded (*i.e.*, not to be exceeded for 100% of the time).[243] SkyBridge and Boeing question the technical analysis performed by Qualcomm, arguing that it is not consistent with the framework accepted in the ITU.[244] One important difference between Qualcomm's operations and most other GSO FSS operations for which we seek protection is that Qualcomm provides "store-and-forward," time-insensitive data communications. For these Qualcomm-type packet services, if a communication signal is damaged it can be retransmitted without degrading the overall quality of the service. Nonetheless, since all of the $EPFD_{down}$ limits (*i.e.*, single-entry validation, single-entry operational, single-entry additional operational, aggregate) we adopt are more stringent, or lower, than the limit of -153.8 dBW/m^2/4kHz that Qualcomm proposes, we find that it is not necessary to address the technical aspects of Qualcomm's analysis or the policy issues regarding protection of secondary or non-conforming services.

(ii) Protection of Very Large Earth Station Antennas

110. *Proposal.* In the NPRM, we proposed that coordination procedures, rather than EPFD limits, be required to protect GSO FSS earth station antennas greater than approximately 10 meters from NGSO FSS interference. We did not propose $EPFD_{down}$ limits in this case because the required limits could preclude NGSO FSS operations altogether. Generally, the larger the GSO FSS earth station, the more stringent the required NGSO FSS $EPFD_{down}$ mask. In the *NPRM*, we also requested comment on the appropriate coordination procedures to be used between these GSO FSS networks and NGSO FSS systems, as well as the specific earth station antenna size that would qualify for special coordination procedures.

111. *Comments.* Although commenters agree in principle with our proposal to require coordination in these special cases, they disagree on the minimum antenna size that would constitute a

[242] Qualcomm Comments at 3.

[243] *Id.* at 4.

[244] SkyBridge Reply Comments at 25 and Boeing Reply Comments at 43-45.

large antenna and the appropriate triggers to be used for coordination. SkyBridge agrees with the Commission that the existing large earth stations should be protected from NGSO FSS interference, but it notes that the special case of large earth stations first should be carefully assessed in order to prevent unnecessarily burdening NGSO FSS systems.[245] Loral states that statistical analysis is necessary to take into account the geographical variation of the EPFD as well as the geographical distribution of large earth stations.[246] PanAmSat asserts that antennas with diameters between 10 meters and 18 meters should be studied further to determine the conditions where coordination is needed to protect existing and future operations.[247]

112. *Decision.* Agreements reached within the ITU-R and at WRC-2000 have confirmed the need for coordination procedures to protect GSO FSS networks using sensitive receiving earth stations with very large antennas.[248] In the 10.7-12.75 GHz frequency band, these agreements apply only to those GSO FSS earth stations with a maximum isotropic gain greater than or equal to 64 dBi (*i.e.*, earth station antennas greater than about 18 meters in diameter), with a G/T of 44 dB/K or higher, and an emission bandwidth of 250 megahertz or higher. We recognize that the ITU-R studies in this area are the most extensive to date and find the agreements to be appropriate for adoption domestically as well. Accordingly, coordination will be required between specific GSO FSS earth stations and NGSO FSS systems meeting the conditions specified in Section 25.146(f).

113. While we are not adopting coordination procedures for antennas between 10 and 18 meters, as originally proposed in the *NPRM*, we did adopt operational $EPFD_{down}$ limits which would provide protection to these GSO FSS earth stations.[249] Information from the Commission's earth station database reveals that the number of earth station antennas greater than 10 meters in diameter is very small -- approximately 20 corresponding to 0.5% of the earth stations licensed by the Commission in the 11.7-12.2 GHz band. Further, almost all of the GSO FSS earth station antennas larger than 10 meters in diameter have been in operation for many years, utilize older technology, and are likely to be phased out over time. This is because advances in satellite earth station technology have given way to today's use of smaller, less costly earth station antennas. We believe it would be detrimental to the nascent NGSO FSS service to adopt $EPFD_{down}$ masks or require coordination to protect the limited number of earth stations that are between 10 and 18 meters in diameter. As recognized by the GSO FSS entities, in the unlikely event of NGSO FSS interference into this limited number of earth stations, GSO FSS operators would have the opportunity to mitigate against any interference.

(iii) Protection of Inclined Orbit Operations

114. *Proposal.* In the *NPRM*, we proposed that protection also be extended to GSO FSS earth stations receiving signals from satellites in inclined geostationary orbit.[250] Specifically, we noted that the

[245] SkyBridge Comments at 47.

[246] Loral Reply Comments at 3.

[247] PanAmSat Reply Comments at 22.

[248] *See* Appendix S5 of the Provisional Final Acts of WRC-2000.

[249] *See* Appendix A, § 25.208(g), which shows operational $EPFD_{down}$ limits for antenna diameters of 3, 6, 9, and $\geq$ 18 meters. The operational $EPFD_{down}$ limits for antenna diameters of between 10 and 18 meters may be found by using linear interpolation.

[250] In order to preserve station-keeping fuel as a satellite nears its end of life, a satellite operator may stop maintaining station-keeping of the satellite in the north-south direction, thus allowing the satellite to drift at an angle of inclination from the GSO arc (*i.e.*, operate in an inclined orbit). North-south station-keeping fuel is one of (continued....)

satellite industry relies on slightly inclined GSO operations to extend the life of a GSO satellite and continue service to customers.[251] For practical purposes, however, we proposed to protect only those GSO FSS satellites that do not exceed a certain degree of inclination and requested comment on what this value of inclination should be.

115. *Comments.* Comments were varied with respect to the maximum degree of inclination that should receive protection. PanAmSat acknowledges that a reasonable limit on the degree of inclination may be necessary.[252] Loral proposes to protect those operations with GSO FSS satellites that are inclined less than or equal to four degrees.[253] Telesat Canada suggests that protection be afforded for inclinations of at least five degrees, and preferably to six degrees.[254] GE submits that any NGSO rules should accommodate GSO FSS satellites that are operating at inclinations of up to 5 degrees.[255] On the other hand, SkyBridge opposes our proposal, claiming that no special requirements are needed for protection of slightly-inclined systems.[256] Again, we note that conclusions have been reached on this issue internationally, both within the ITU-R and at WRC-2000.[257]

116. *Decision.* The ITU-R concluded that no additional protection is needed for earth stations operating with GSO FSS satellites inclined up to 2.5 degrees. Operations with GSO FSS satellites inclined greater than 2.5 degrees and less than or equal to 4.5 degrees would, however, receive additional protection through the operational limits. We believe this is the appropriate approach for adoption domestically and have incorporated these operational $EPFD_{down}$ limits into our Rules.[258] Protection of operations for GSO FSS satellites inclined greater than 4.5 degrees is more difficult because inclined operations basically extend the north-south extension of the geostationary satellite orbit. However, the number of U.S. licensed satellites that continue to provide service while at inclinations greater than 4.5 degrees is extremely limited,[259] and Section 25.280 of the Commission's Rules does not provide additional protection to GSO FSS satellites beyond that provided to GSO FSS satellites that are operating without inclination.[260] Thus, we do not adopt specific protection requirements for GSO operations

(Continued from previous page)
the main factors that limits a satellite's life. A satellite in inclined orbit is able to drift within a pre-defined north and south boundary, for example ± 5 degrees from its nominal orbit location. Non-inclined geostationary satellites are maintain drift by only ± 0.05 degrees or less in the north-south or the east-west directions of the assigned orbital positions.

[251] *NPRM* at ¶ 27.

[252] PanAmSat Comments at 19.

[253] Loral Comments at 6.

[254] Telesat Canada Comments at 7.

[255] GE Comments at 23.

[256] *See* SkyBridge Comments at 53 and SkyBridge Reply Comments at 34.

[257] *See* Table S22-4A of the Provisional Final Acts of WRC-2000, which defines single-entry operational $EPFD_{down}$ limits as a function of the orbital inclination of the GSO satellite.

[258] *See* 47 C.F.R. § 25.208.

[259] At the present time, one U.S. GSO FSS satellite operates within the inclination angle of 4.5 degrees and another such satellite operates near this angle.

[260] *See* 47 C.F.R. § 25.280. *See, e.g., AT&T Corp. Application for Modification of TELSTAR 303 Domestic Fixed-Satellite,* Order and Authorization, 11 FCC Rcd 10570 (1999).

inclined beyond 4.5 degrees. However, we urge both NGSO and GSO operators to make good faith efforts to coordinate their respective operations.

(iv) Protection of GSO FSS Telemetry, Tracking and Command

117. *Proposal.* In the *NPRM*, we sought comment on the adequacy of the WRC-97 provisional limits to protect GSO FSS TT&C operations in three separate modes of operation; operational (on orbit), transfer orbit (launch phase), and emergency phase.[261] For protection of the operational phase of telemetry downlinks, we noted that although the probability of occurrence of NGSO interference would be low, such an event could have significant and possibly catastrophic impact on TT&C operations. We requested comment on the adequacy of the provisional limits to protect telemetry downlink operations. We proposed that GSO FSS and NGSO FSS licensees consult with each other to avoid interference during GSO FSS transfer orbit operations. Further, we requested comment on how to protect GSO FSS operations in emergency situations.

118. *Comments.* Comments were mixed regarding of protection of the operational phase TT&C. PanAmSat argues that the nature of TT&C operations requires protection not only during the launch phase, but at all other times as well.[262] PanAmSat further proposes that the only solution is to segment the TT&C bands from standard frequencies and to prohibit NGSO FSS operation on these frequencies.[263] Loral and SkyBridge believe that the $EPFD_{down}$ and $EPFD_{up}$ limits ultimately adopted will adequately protect GSO TT&C links in operational mode, and no additional measures are required.[264] For protection of "transfer orbit" operations, commenters support the Commission's proposal for consultation between GSO FSS and NGSO FSS licensees.[265] With respect to "emergency" operations, SkyBridge asserts that any operator (GSO or NGSO) should be permitted to use all means at its disposal to reacquire communications and regain control of its spacecraft.[266] In fact GE agrees that in an emergency situation, parties should be able to exceed limits in order to recover control of the spacecraft.[267]

119. *Decision.* Because of the critical nature of transfer orbit operations, we adopt the proposal in the *NPRM* to require consultation between GSO FSS and NGSO FSS licensees to minimize the impact of interference. The impact of NGSO FSS operation on GSO FSS transfer orbit operations will be infrequent and of a short time period, therefore, these events can be coordinated ahead of time in order to avoid unacceptable interference. With respect to emergency TT&C operations, there was agreement within the ITU-R that, during emergency operations in general, any GSO or NGSO FSS operator should be allowed to use any means necessary to regain communications with the satellite. We agree with this position because the measures required to reacquire communications and regain control of the GSO satellite cannot be predetermined. Although we do not adopt any specific measures for NGSO

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[261] *NPRM* at ¶¶ 29-31.

[262] PanAmSat Comments at 24.

[263] *Id.* at 25. By providing a guardband around these frequencies of 1 megahertz on either side produces an exclusion zone of only 3 megahertz for the command frequencies and 4 megahertz for the telemetry frequencies.

[264] SkyBridge Comments at 54 and Loral Comments at 13.

[265] Loral Comments at 7, GE Comments at 23, SkyBridge Comments at 54, and Telesat Canada Comments at 8.

[266] SkyBridge Comments at 55.

[267] GE Comments at 24.

FSS systems to protect GSO FSS systems during emergency TT&C operations, we urge both GSO FSS and NGSO FSS operators to coordinate with each other if such a situation were to occur. The ITU-R, however, was not conclusive with respect to the protection of the operational phase TT&C. There has not been any demonstration that leads us to believe that the telemetry downlinks will not be protected by the $EPFD_{down}$ limits we adopt today. We will not, therefore, adopt specific measures for NGSO FSS protection of GSO FSS telemetry downlink operations at this time. We will closely follow, however, the ongoing work within the ITU-R and consider its conclusions in the development of conditions, if necessary, to be placed on NGSO FSS licensees.[268]

3. NGSO FSS Gateway Uplink Bands: 12.75-13.25 GHz

120. *Current allocations.* The *NPRM* stated that the 12.75-13.25 GHz band requested for NGSO FSS gateway uplinks is allocated on a co-primary basis to fixed, FSS uplink, and mobile operations. This band is primarily used by Part 74 BAS, Part 78 CARS, and Part 101 fixed microwave operations. Television stations use the fixed allocation for BAS studio-transmitter links and the mobile allocation for electronic news gathering ("ENG"). CARS licensees use this band to send video signals between points in their networks. GSO FSS operations in this band must meet the requirements of the ITU Appendix 30B plan, and Part 2 of the Commission's Rules limits these operations to international systems.[269] Similar to the 10.7-11.7 GHz band, the international system only requirement for GSO FSS uplink operations has limited the number of earth stations in this band.[270] Further, the band may also be used for vital TT&C functions for GSO FSS satellites.[271]

121. *Proposal.* The *NPRM* indicated that there is significant deployment of terrestrial operations in this band, but concluded that spectrum sharing with NGSO FSS operations was possible. The *NPRM* also proposed to limit NGSO uplink operations in the 12.75-13.25 GHz band to gateway type uplink operations subject to the coordination and the sharing criteria proposed for the 10.7-11.7 GHz downlink operations. Similar to the 10.7-11.7 GHz band, the *NPRM* proposed to amend footnote NG104 in this band to allow domestic NGSO FSS operations, but did not propose to remove the international system only requirement for GSO FSS operations. Additionally, the *NPRM* asked for comment on its tentative conclusion that exclusion zones were not needed for NGSO FSS gateways in the 12.75-13.25 GHz band because the band, already extensively used by terrestrial operations, was not targeted for relocated fixed systems.[272]

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[268] Preliminary ITU-R studies indicate that: (1) sufficient protection of telemetry downlinks will be provided by $EPFD_{down}$ limits and no special conditions are required; and (2) to not unduly constrain the design of NGSO FSS systems, it may be useful to locate GSO TT&C carriers in specific portions of the band (*i.e.*, near the band edge).

[269] *See* ITU Radio Regulations, Appendix 30B and 47 C.F.R. § 2.106 footnote NG104. We note that there is one licensee using the U.S. Appendix 30B assignment in this band for domestic feeder links for a GSO MSS system.

[270] Our database indicates that there are 9 authorizations issued for GSO FSS earth stations in the 12.75-13.25 GHz band. These authorizations do not indicate the actual number of earth stations or antennas that a licensee might deploy. Additionally, this number may not include several international earth station authorizations issued before 1995 when the IBFS database was created.

[271] *NPRM* at ¶ 32.

[272] *Id.* at ¶¶ 33-36.

122. *Decision.* We will permit NGSO FSS gateway uplink stations to operate in the 12.75-13.25 GHz band on a co-primary basis with incumbent users, except that we will not allow NGSO FSS to operate at 13.15-13.2125 GHz, which is discussed in detail below. We also conclude that although we will permit NGSO FSS operations in this band, we will not remove the requirement that GSO FSS operations be limited to international systems. As we discussed above regarding the 10.7-11.7 GHz band, we believe that the growth of incumbent services would be significantly inhibited if we were to authorize domestic and international GSO FSS use of the 12.75-13.25 GHz band, due to the large number of GSO FSS earth stations that would likely be deployed, and we note that other bands are available for GSO FSS growth.

a. NGSO FSS Gateways Sharing with BAS Operations

123. *Comments.* SBE states that the coordination procedures proposed in the *NPRM* may be sufficient for spectrum sharing between NGSO FSS gateways and fixed, point-to-point BAS links, but no such sharing would be possible with mobile TV pickup stations (*e.g.*, helicopter, blimp, and ENG operations) or stations used at temporary locations with remote steerable antennas.[273] SBE points out that the 12.70-13.25 GHz band is heavily used by BAS operations, particularly in the top TV markets, and the need for additional facilities for digital television use is expected to increase even though the Commission recently reduced the amount of spectrum allocated for BAS in the 2 GHz range.[274] Although SBE contends that a new NGSO FSS gateway station could preclude any additional BAS operations across the entire 12.75-13.25 GHz band over the entire range of angles the gateway antenna uses, SBE states that experiences with other satellite operations attempting to share with BAS operations may exclude NGSO FSS gateway stations due to their inability to protect existing BAS operations. As discussed above, SBE supports the concept of geographic protection areas, such as growth zones, for locating NGSO FSS gateway earth stations to ensure that mobile and temporary fixed BAS can operate in major metropolitan areas.[275] SBE also states that NGSO FSS gateway operations must not be allowed to operate on BAS channels A19, A20, B19 and B20 in the 13.15-13.2125 GHz band, which is reserved for TV pickup operations under Section 74.602 of the Commission's Rules.[276]

124. Boeing asserts that its proposed system should not adversely impact BAS operations because it anticipates only two planned gateway stations in the U.S. Boeing states that its proposed 4.5 meter gateway uplink antennas will require unobstructed fields-of-view from elevation angles greater than or equal to 10 degrees from the horizon, reducing the amount of energy transmitted towards the horizon and thus enabling sharing with terrestrial operations with less geographic separation. Boeing states that it will be able to provide data regarding its gateway uplink transmissions to nearby terrestrial service entities and that it will contact nearby television stations to arrange communications paths for BAS operations through periodic information on hourly/daily variations in interference contours.[277] SkyBridge contends that TV pickup operations are secondary in the 12.7-13.25 GHz band, and must accept interference from CARS and STL transmitters. SkyBridge also argues that because of the

[273] SBE Comments at 1.

[274] *Id.* at 2; SBE October 8, 1997 Comments at 4.

[275] *See* SBE Reply Comments at 2.

[276] *Id.* at 3.

[277] Boeing Reply Comments at 22.

propagation characteristics of this band, TV stations use it only for short pickup links and often at ground level where the links are shielded from interfering signals by buildings.[278]

125. *Decision.* Because BAS operations have primary allocation status in the 12.75-13.25 GHz band, such incumbent operations are entitled to interference protection from NGSO FSS gateway uplinks. Further, we find that it is important to allow BAS operations to maintain flexibility in establishing temporary links and operating mobile ENG operations. As discussed above, some form of geographic protection area will be developed for locating NGSO FSS gateway earth stations that should prevent NGSO FSS gateways from hindering mobile and temporary fixed BAS use of this band. As we discuss below, we conclude that fixed BAS and CARS operations can coordinate with NGSO FSS gateway stations, and new coordination procedures for use by these services must be developed.

126. Regarding protection of mobile BAS operations, we note that section 74.602 of our rules provides for the exclusive use of channels A19, A20, B19 and B20 in the 13.15-13.2125 GHz band by TV BAS and CARS pickup operations within 50 km of the top 100 television markets.[279] In order to permit BAS and CARS entities to continue remote pickup operations throughout the U.S., we are extending exclusive use of the 13.15-13.2125 GHz band for BAS and CARS pickup operations to all 211 TV markets, thereby precluding NGSO FSS operations from this band segment. We find that this will not have a significant impact on NGSO FSS satellite operations because of the remaining amount of gateway uplink spectrum being made available. We take this action with the expectation that BAS mobile operations, especially those in TV markets where BAS is not extensively deployed, will concentrate their mobile use on the four channels in the 13.15-13.2125 GHz band, thereby leaving the remaining portion of the 12.75-13.25 GHz band spectrum available for NGSO FSS use.

b. NGSO FSS Gateway Coordination with Terrestrial Operations

127. *Comments.* The issues concerning coordination between NGSO FSS gateway operations and terrestrial fixed operations in the 12.75-13.25 GHz are generally the same as those addressed above for coordination in the 10.7-11.7 GHz band. Basically, commenters support the use of existing coordination procedures for terrestrial fixed operations (including CARS, BAS and FS links) as proposed in the *NPRM*. Comsearch states that the apparent large number of CARS links in this band are due to the Commission's licensing individually each 6 MHz television channel carried by CARS.[280] For example, a CARS path with a full 500 megahertz cable baseband would count as 84 authorized links in the Commission database. However, in terms of transmission paths, Comsearch asserts that the 12.75-13.25 GHz band is not as extensively used as the 10.7-11.7 GHz band, and thus the 12.75-13.25 GHz band has growth potential. Additionally, SBE states that existing coordination procedures would not be sufficient for sharing between NGSO FSS gateways and mobile TV pickup stations or stations used at temporary locations with remote steerable antennas.[281]

128. *Decision.* We conclude that NGSO FSS gateway uplink stations can operate in the 12.75-13.15 GHz and 13.2125-13.25 GHz bands on a co-primary basis with FS operations, using

[278] SkyBridge Reply Comments at 55.

[279] *See* 47 C.F.R. § 74.602. TV pickup stations are land mobile stations used for the transmission of material from scenes of events occurring at points removed from the TV broadcast studio to the TV broadcast station, *see* 47 C.F.R. §74.601(a). There are currently 211 television markets in the U.S. Broadcast and Cable Yearbook 1998 at B234.

[280] Comsearch Comments at 5.

[281] SBE Comments at 1.

coordination procedures. As an initial matter, we find that Part 74 and Part 78 terrestrial fixed operations should be able to coordinate with NGSO FSS gateway stations under the coordination procedures set forth in Part 101 and Part 25. As we discussed above, NGSO FSS and fixed operations in the 10.7-11.7 GHz band will be able to coordinate their operations under the procedures in Part 101 for fixed operations and Part 25 for satellite operations. The NGSO FSS and fixed operations in the 12.75-13.25 GHz band are technically similar to operations in the 11 GHz band; thus, coordination with fixed links at 13 GHz under existing procedures also is possible. Part 74 BAS operations and Part 78 CARS operations have their own coordination procedures, but these procedures do not provide for sharing with NGSO FSS operations,[282] and existing coordination procedures for FSS operations do not address coordination between satellite and mobile or BAS and CARS operations. For example, BAS is often licensed for the entire 12.7-13.25 GHz range, providing flexibility to coordinate temporary operations locally with other licensees in the band. While these procedures have worked with regard to fixed operations because unused individual channels can be identified and made available on an informally coordinated basis to the mobile BAS operation, we believe that this type of coordination flexibility for BAS could be difficult to achieve with NGSO FSS gateway uplink stations, which may use all available frequencies in an area. Therefore, we conclude that new coordination procedures need to be developed for sharing between NGSO FSS and BAS and CARS operations in the 12.75-13.25 GHz band. Accordingly, we are deferring to a later proceeding a decision on specific coordination procedures that will be used for BAS/CARS and NGSO FSS operations in this band. Further, we will not license any NGSO FSS earth station in the 12.75-13.15 GHz and 13.2125-13.25 GHz bands until appropriate coordination rules are adopted.

c. NGSO FSS Gateways Sharing with GSO FSS Uplinks

129. *Proposal.* As noted in the *NPRM,* WRC-97 adopted a provisional $EPFD_{up}$ limit to protect GSO FSS satellite receivers in the 12.75-13.25 GHz band from transmitting earth stations in a NGSO FSS system. In the *NPRM* we also expressed our belief that the $EPFD_{up}$ limit needed to protect GSO FSS uplink operations would not vary greatly from the WRC-97 provisional limit.[283] Further, we asked for technical analysis to support the appropriate $EPFD_{up}$ limit to protect inclined orbit operations and for proposals regarding the level of inclination that merits protection. We also requested comment on whether the $EPFD_{up}$ definition should take into account GSO satellite receive antenna directivity and requested information on the appropriate satellite receive antenna reference pattern(s) that should be considered in developing a modified $EPFD_{up}$ definition.[284]

130. *Comments.* While sharing between NGSO FSS and GSO FSS at 13.75-14.0 GHz, 14.0-14.4 GHz and 14.4-14.5 GHz will be discussed below, we find that it is appropriate to discuss here comments regarding $EPFD_{up}$ limits applicable to all NGSO FSS uplink frequency bands. Many commenters supported the adoption of the WRC-97 provisional limits along with the definitional change to include the GSO satellite receive antenna reference pattern in the $EPFD_{up}$ calculation in a similar manner as the GSO earth station receive antenna pattern is included in the $EPFD_{down}$ calculation.[285] Telesat Canada states that the revised definition would be acceptable as long as the resulting interference

[282] *See* 47 C.F.R. §§ 74.602, 74.638, 78.36.

[283] *NPRM* at ¶ 36.

[284] *Id.* at ¶ 37.

[285] Loral Comments at 8, Boeing Comments at 34, SkyBridge Reply Comments at 29, and STA Comments at 4-5.

into GSO FSS uplinks is less than or the same as the interference with the previous definition.[286] PanAmSat, however, states that the definition of $EPFD_{up}$ should remain to protect more susceptible GSO FSS networks with large beam coverage areas and large beam angles.[287]

131. *Decision.* NGSO FSS systems will have to meet the same $EPFD_{up}$ limit at the geostationary satellite orbit, regardless of whether the NGSO FSS system transmission emanates from a gateway or user earth station facility. In order to protect uplinks to GSO FSS satellites, we adopt the single-entry validation $EPFD_{up}$ limits as adopted by WRC-2000, as new rule Section 25.146(h). The definition of $EPFD_{up}$ includes information regarding the GSO satellite receive antenna directivity for the same reason that the GSO FSS receive earth station antenna pattern is included in the $EPFD_{down}$ definition. Specifically, accounting for GSO FSS satellite antenna directivity limits the number of NGSO FSS earth stations contributing interference in the direction of the GSO satellite and provides a more realistic calculation of the interference level received. Further, the reference GSO FSS space station antenna patterns contained in ITU-R Recommendation S.672 were adopted for the calculation of $EPFD_{up}$.[288] As noted by Boeing, the JTG 4-9-11 reached a consensus agreement that the provisional $EPFD_{up}$ limit is appropriate, even in light of the change in definition.[289] We also find that the $EPFD_{up}$ limits we are adopting will also protect GSO FSS satellites operating in inclined orbits. We also find that the same implementation procedures adopted for the validation $EPFD_{down}$ limits described in paragraphs 88 above are also appropriate for adoption for the $EPFD_{up}$ limits.

d. OpTel Petition

132. *Proposal.* The *NPRM* also requested comment on a request by OpTel, Inc. ("OpTel"), an operator of private cable systems, to amend Parts 78 and 101 of the Commission's Rules to allow licensees in the fixed microwave service to use frequencies in the 12.7-13.25 GHz band to transmit video programming material to end users.[290] Specifically, OpTel requests that Part 78 be amended to make fixed licensees eligible for licenses in the CARS band and that Part 101 be amended to allow fixed licensees to use the 12 GHz band for video programming. The *NPRM* sought comment on whether operations as proposed by OpTel would conflict with potential NGSO FSS operations in the 12.75-13.25 GHz band. Further, on July 14, 1999, the Commission released a Notice of Proposed Rule Making in CS Docket No. 99-250[291] which proposed to allow private cable operators ("PCOs") to use the 12.70-13.25

[286] Telesat Canada Comments at 4.

[287] PanAmSat Comments at 16 and STA Comments at 4-5.

[288] *See* ITU-R Recommendation S.672, "Satellite Antenna Radiation Pattern for use as a Design Objective in the Fixed-Satellite Service Employing Geostationary Satellites." The reference GSO FSS space station antenna patterns used in the calculation of $EPFD_{up}$ are the single-feed patterns defined in this recommendation, assuming a peak gain of 32.4 dBi, a beamwidth of 4 degrees, and a first side lobe level of –20 dB.

[289] *See* Doc. JTG 4-9-11/TEMP/40(Rev.2). The new definition, $EPFD_{up}$ takes into account GSO satellite receive antenna directivity in order to make a more accurate assessment of interference caused by NGSO FSS networks.

[290] *See* OpTel Petition for Rule Making, RM-9257, filed April 1, 1998.

[291] *See* Petition for Rule Making to Amend Eligibility Requirements in Part 78 Regarding 12 GHz Cable Television Relay Service, *Notice of Proposed Rule Making*, CS Docket No. 99-250, 14 FCC Rcd 11967 (1999).

GHz band to provide MVPD services, under existing technical and operational rules (*e.g.*, one-way, point-to-point,[292] narrow antenna beam transmissions).

133. *Comments.* OpTel argues that if NGSO FSS can share the 13 GHz band with CARS, PCO operations also can share the band with NGSO FSS operations because PCOs are analogous to CARS operations.[293] Similarly, SkyBridge states it can share with PCO operations as long as PCOs comply with the existing terrestrial operational requirements in this band. However, SkyBridge cautions against expanding terrestrial uses of the band to include dissimilar operations, such as point-to-multipoint operations, wide-beam antennas, or the introduction of a different licensing regime, because such uses could inhibit sharing between the FS and NGSO FSS.[294]

134. *Decision.* We find that NGSO FSS gateway stations should be able to share the 12.75-13.15 GHz and 13.2125-13.25 GHz bands with CARS eligibles, provided those operations use technical and operational techniques such as one-way, point-to-point, narrow beam antenna transmissions, as required under existing rules, that facilitate coordination. As indicated above, some issues that might affect operations in the 12.75-13.15 GHz and 13.2125-13.25 GHz bands will be deferred to a future proceeding, such as possible geographic protection areas, some coordination issues, and other NGSO FSS gateway parameters. We also note that the Commission has not yet decided whether to expand CARS eligibility to include PCO operations in the 12.75-13.25 GHz band; this decision will be made in CS Docket No. 99-250.[295] Nonetheless, the sharing potential between NGSO FSS and CARS depends primarily on the technical and operation characteristics of the services, not licensee eligibility. Consequently, we see no need to defer our decision regarding NGSO FSS use of this band.

4. NGSO FSS Gateway Uplink Bands: 13.75-14.0 GHz

135. *Current allocations.* In the *NPRM*, we noted that the 13.75-14.0 GHz band is allocated on a co-primary basis to the FSS and Federal Government radiolocation operations, such as high-powered mobile radar systems.[296] The FSS allocation, adopted domestically in 1996, requires that FSS systems meet the following technical constraints agreed internationally and included in footnotes S5.502 (WRC-95), S5.503 (WRC-95), and S5.503A (WRC-95): 1) the e.i.r.p. of any emission from an earth station in the FSS shall be at least 68 dBW, and should not exceed 85 dBW, with a minimum antenna diameter of 4.5 meters; and 2) the e.i.r.p. density of emissions from an earth station in the FSS shall not exceed 71 dBW per 6 megahertz in the 13.772-13.778 GHz frequency range.[297] The *NPRM* indicated that current FSS uplink use of the 13.75-14.0 GHz band is relatively light given the short period of time since this service has been permitted to use the band and the prevalence of Federal Government operations.[298] We further noted in the *NPRM* that the band is allocated on a secondary basis to the

[292] CARS stations also may transmit in a hub configuration, distributing signals to multiple individually coordinated receiver sites. This "point-to-multipoint" configuration does not include transmissions to multiple, unspecified receiving locations. *See Notice of Proposed Rule Making*, CS Docket No. 99-250, at n.8.

[293] OpTel Comments at 3.

[294] SkyBridge Comments at 76.

[295] *See Notice of Proposed Rule Making*, CS Docket 99-250, 14 FCC Rcd 11967 (1999).

[296] *NPRM* at ¶ 38.

[297] *See* Amendment of Parts 2, 25, and 90 of the Commission's Rules to Allocate the 13.75-14.0 GHz Band to the Fixed-Satellite Service, ET Docket No. 96-20, *Report and Order*, 11 FCC Rcd 11951 (1996).

[298] *NPRM* at ¶ 38.

standard frequency and time satellite service and space research service,[299] for operations such as the NASA TDRSS and spaceborne sensors that provide weather and other significant data.[300] However, space research service operations authorized prior to January 31, 1992 continue to operate on a co-primary basis.[301] Further, Footnote US337 requires that FSS earth stations in the 13.75-13.80 GHz band be coordinated on a case-by-case basis in order to minimize harmful interference to Federal Government TDRSS operations.[302]

136. *Proposal.* In the *NPRM*, we proposed to allow NGSO FSS gateway uplink operations in the 13.8-14.0 GHz portion of the 13.75-14.0 GHz band. We did not propose to allow such operations in the 13.75-13.80 GHz band segment in order to protect NASA TDRSS operations.[303] To facilitate sharing with incumbent Federal Government operations at 13.80-14.0 GHz, we proposed to apply the e.i.r.p. and minimum antenna diameter limits set forth in footnotes S5.502 and S5.503 and noted above. We further proposed to require coordination of all FSS earth stations located in the United States and insular areas, including NGSO FSS gateway stations, with Federal Government operations through the normal Frequency Assignment Subcommittee ("FAS") process of the Interdepartment Radio Advisory Committee ("IRAC").[304] We noted the concerns of the Department of Defense ("DoD") and NTIA that the operating parameters adopted for FSS operations in the band do not consider NGSO services, and that if such services are permitted, they must do so in accord with the technical constraints for the FSS in the band and must accept interference from the radiolocation service.[305] Additionally, we requested comment and proposals on the appropriate technical requirements to enable NGSO FSS uplinks to share the 13.80-14.0 GHz band with GSO FSS and Federal Government operations.[306] Finally, we stated that if sufficient technical analysis is submitted to demonstrate the feasibility of NGSO FSS sharing with NASA operations at 13.75-13.80 GHz, we would consider permitting NGSO FSS operations in that band segment.[307]

137. *Comments.* Boeing supports our proposal to permit NGSO FSS gateway uplink operations in the 13.80-14.0 GHz band by applying the GSO FSS's e.i.r.p. and minimum antenna diameter limits for the band to NGSO FSS operations.[308] Boeing asserts that uniform rules for all the

[299] The standard frequency and time signal-satellite service is a radiocommunication service using space stations on earth satellites for scientific, technical and other purposes, providing the transmission of specified frequencies, time signals, or both, of stated high precision, intended for general reception. This service may include feeder links necessary for its operation. The space research service is a radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes. See 47 C.F.R. § 2.1.

[300] *Id.*

[301] *See* 47 C.F.R. § 2.106 footnote S5.503.

[302] *See* 47 C.F.R. § 2.106 footnote US337.

[303] *NPRM* at ¶ 39.

[304] *Id.* at ¶ 42.

[305] *Id.* at ¶ 40.

[306] *Id.* at ¶ 44.

[307] *Id.* at ¶ 43.

[308] Boeing Comments at 38.

proposed NGSO FSS gateway uplink bands allow a common design and operational approach for NGSO FSS gateway operations.[309] Specifically, Boeing proposes that, as in the 12.75-13.25 GHz band, we adopt a new definition of $EPFD_{up}$ along with the associated reference Ku-band NGSO FSS satellite receive antenna pattern developed by JTG 4-9-11. Boeing also proposes that we protect inclined GSO satellites by applying to the 13.80-14.0 GHz band the same $EPFD_{up}$ limits as in the 12.75-13.25 GHz band. Boeing states that its proposed $EPFD_{up}$ definition allows multiple NGSO systems to operate with insignificant interference impact to normal GSO FSS and inclined GSO FSS operations. Finally, Boeing proposes that we withhold judgment on whether spectrum sharing is feasible in the 13.75-13.80 GHz band until studies are completed by JTG 4-9-11.[310]

138. GE states that if we decide to permit NGSO FSS gateway uplink operations in the 13.75-14.0 GHz band, we should also permit GSO FSS providers to use that band at the same reduced power level as those proposed for NGSO FSS systems by SkyBridge.[311] GE states that NGSO FSS providers would have a competitive advantage if they can use spectrum that is not also available to GSO FSS providers or are constrained by different regulatory requirements.[312]

139. SkyBridge urges the Commission to permit NGSO FSS systems to use the 13.75-13.80 GHz band segment.[313] SkyBridge proposes that we apply footnote US337[314] to NGSO FSS systems in that band, which would require such systems to coordinate on a case-by-case basis through NTIA's FAS to minimize harmful interference to TDRSS downlinks, thus ensuring that only those systems able to protect TDRSS operations will operate at 13.75-13.80 GHz.[315]

140. NASA disagrees with SkyBridge, contending that technical studies NASA performed and submitted to JTG 4-9-11 and US Working Party 4A indicate that the viability of the 13.75-13.80 GHz link between TDRSS satellites and low orbiting spacecraft, such as the Space Shuttle, would be threatened by operation of the SkyBridge system.[316] NASA also contends that its studies were based on technical characteristics of the SkyBridge system alone, and thus if other NGSO FSS systems also were permitted to operate at 13.75-13.80 GHz, the TDRSS interference budget would be further compromised.[317]

141. Since these comments were filed, the ITU-R – in preparation for WRC-2000 and with active participation from U.S. Government and industry – has further studied spectrum sharing between NGSO FSS and Federal Government operations and modified footnotes S5.502 and S5.503 at WRC-

[309] *Id.* at 39.

[310] *Id.* at 40.

[311] GE Reply Comments at 10.

[312] *Id.*

[313] SkyBridge Comments at 14.

[314] *See* 47 C.F.R. § 2.106 footnote US337.

[315] SkyBridge Reply Comments at 10.

[316] Letter of April 9, 1999 from David Struba, NASA IRAC Representative to William Hatch, Chairman, IRAC, at 1.

[317] *Id.* at 2.

2000 to accommodate NGSO FSS operations. While retaining the existing antenna size requirement for FSS operations in the 13.75-14.0 GHz band, footnote S5.502 was modified in such a way as to allow FSS earth stations to operate with an e.i.r.p. of less than 68 dBW and to change the e.i.r.p. limit of radiolocation operations to apply in all cases instead of only towards the geostationary orbit. S5.502 (WRC-2000) also added the following language "[t]he protection of assignments to receiving space stations in the fixed-satellite service operating with earth stations that, individually, have an e.i.r.p. of less than 68 dBW shall not impose constraints on the operation of the radiolocation and radionavigation stations operating in accordance with the Radio Regulations. No. S5.43A does not apply." This action effectively allowed FSS earth stations to operate at powers lower than 68 dBW as long as they do not constrain radiolocation operations. Further, footnote S5.503 maintained its e.i.r.p. limits for GSO FSS operations to protect space research in the 13.772-13.778 GHz segment and added the following requirement for NGSO FSS earth stations: "The e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in non-geostationary-satellite orbit shall not exceed 51 dBW in the 6 MHz from 13.772-13.778 GHz." This e.i.r.p. limit on NGSO FSS earth stations in the 13.772-13.778 GHz segment was intended to protect NASA TDRSS operations from NGSO FSS operations.[318] However, WRC-2000 could not reach agreement on whether the technical parameters in S5.502 (WRC-2000) and S5.503 (WRC-2000) would enable compatibility between the fixed-satellite, space research, radiolocation, and radionavigation services. Instead, WRC-2000 set up an ITU-R joint task group to further study the sharing conditions between the systems operating in the services allocated to the frequency band 13.75-14.0 GHz and to report its findings to WRC-03.[319]

142. In response to the WRC-2000 changes, NTIA notes that the minimum e.i.r.p. limit of 68 dBW for FSS earth stations contained in S5.502 (WRC-95) was based on ITU-R studies and facilitated the protection of GSO space station receivers.[320] NTIA asserts that GSO space stations receiving from earth stations with an e.i.r.p. of less than 68 dBW and NGSO space station receivers, sharing with the radar operations may prove to be difficult. NTIA states that interference to these space stations will occur under certain scenarios; the only questions are how often and for how long. Based on the operating requirements of Federal Government radar stations, the Federal agencies will not be able to make any modifications to resolve these interference problems. Since the FSS space stations will be susceptible to interference from radiolocation stations in the band 13.75-14 GHz, NTIA contends that the FSS satellite systems that are licensed should be designed and operated such that their operations are compatible with the radiolocation service. Therefore, NTIA requests that all FSS applicants be informed of this situation.

143. *Decision.* We adopt our proposal to allow NGSO FSS Gateway uplink operations in the 13.8-14.0 GHz band and find that the agreements at WRC-2000 justify permitting NGSO FSS Gateway uplink operations in the 13.75-13.80 GHz portion as well. Although DoD and NTIA express some reservations, they are primarily concerned about interference that may be caused to FSS operations from the radiolocation service. Further, NTIA is concerned with WRC-2000 changes to footnote S5.502 would constrain radiolocation operations by limiting the e.i.r.p. of a radiolocation station to 59 dBW in all directions, rather than just in the direction of the geostationary orbital arch, as previously required. While these concerns continue to be an issue that will be addressed at WRC-2003, we see no reason to withhold this band from NGSO FSS use. FSS entities were aware of existing high powered radiolocation operations when they requested access to this spectrum. Therefore, we believe FSS systems can design

[318] *See* Provisional Final Acts of WRC-2000, No. S5.503.

[319] *See* Resolution 733(WRC-2000), "Review of sharing conditions between services in the band 13.75-14 GHz."

[320] *See* October 20, 2000 Letter from William T. Hatch, Associate Administrator, Office of Spectrum Management, NTIA, to Dale Hatfield, Chief, Office of Engineering and Technology.

their satellites to compensate for incumbent operations and find usable spectral capacity in this spectrum. At the same time, FSS entities will not be permitted to claim protection from radiolocation operations.

144. At this time, we are not implementing the specific WRC-2000 changes to footnote S5.502 in our Table of Frequency Allocations due to concerns of NTIA. However, some aspects of the new footnote are worth adopting, such as removing the minimum power requirement on FSS operations in the 13.75-14.0 GHz band. As stated above, FSS licensees are aware of the interference environment in this band due to incumbent radiolocation operations and should be permitted to operate at lower powers if they can achieve communications. Therefore, we are adopting a new footnote US356 that is the same as the old footnote S5.502 regarding limits on radiolocation operations, but it removes the minimum power requirement for FSS operations. Further, to prevent confusion, we will delete S5.502 from our Table of Frequency Allocations. New footnote US356 reads as follows:

US356 In the band 13.75-14 GHz, an earth station in the fixed-satellite service shall have a minimum antenna diameter of 4.5 m and the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW. In addition the e.i.r.p., averaged over one second, radiated by a station in the radiolocation service towards the geostationary-satellite orbit shall not exceed 59 dBW. Receiving space stations in the fixed-satellite service shall not claim protection from radiolocation transmitting stations operating in accordance with the United States Table of Frequency Allocations. ITU Radio Regulation No. S5.43A does not apply.

145. Regarding specific concerns with TDRSS operations in the 13.75-13.80 GHz portion and the WRC-2000 changes to footnote S5.503, we note that the 51 dBW/6 megahertz e.i.r.p. density limit was developed considering TDRSS operations and should be adequate. However, NTIA indicates that NASA has requirements for TDRSS protection across a 10 megahertz segment at 13.77-13.78 GHz to accommodate communications with the International Space Station.[321] We find it is important to protect TDRSS operations in this band because they support missions that include manned flight. Therefore, we will extend the e.i.r.p. density limit across the 10 megahertz segment as requested by NTIA by adopting new footnote US357 for all FSS earth stations, which accomplishes the goals of S5.503 (WRC-2000), but protects TDRSS across the 13.77-13.78 GHz band. Accordingly, we remove footnote S5.503 from our Table of Frequency Allocations. We also modify Section 25.204(f) of our Rules to reflect these new power requirements for FSS operations in the 13.75-14.0 GHz band. We believe this limit will protect NASA TDRSS operations from different types of NGSO FSS systems and not only the SkyBridge specific design. Nevertheless, we maintain the requirements of US337 that earth stations in the FSS coordinate on a case-by-case basis with the FAS in order to minimize interference to TDRSS operations. Any further interference concerns regarding NGSO FSS and TDRSS operations can be addressed further in the coordination process. US357 reads as follows:

> US357 In the band 13.75-14 GHz, geostationary space stations in the space research service for which information for advance publication has been received by the ITU Radiocommunication Bureau (Bureau) prior to 31 January 1992 shall operate on an equal basis with stations in the fixed-satellite service; after that date, new geostationary space stations in the space research service will operate on a secondary basis. Until those geostationary space stations in the space research service for which information for advance publication has been received by the Bureau prior to 31 January 1992 cease to operate in this band:

[321] *See* August 7, 2000 Letter from David P. Struba, NASA IRAC Representative, to Norbert Schroeder, Acting Chairman IRAC.

a) the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in geostationary-satellite orbit shall not exceed 71 dBW in any 6 MHz band from 13.77 to 13.78 GHz;

b) the e.i.r.p. density of emissions from any earth station in the fixed-satellite service operating with a space station in non-geostationary-satellite orbit shall not exceed 51 dBW in any 6 MHz band from 13.77 to 13.78 GHz.

Automatic power control may be used to increase the e.i.r.p. density in any 6 MHz band in this frequency range to compensate for rain attenuation, to the extent that the power flux-density at the fixed-satellite service space station does not exceed the value resulting from use by an earth station of an e.i.r.p. of 71 dBW or 51 dBW, as appropriate, in any 6 MHz band in clear-sky conditions.

146. We find that the technical requirements adopted are adequate to permit spectrum sharing throughout the 13.75-14.0 GHz band. Further, any additional frequency sharing concerns can be addressed in the coordination process of FSS earth stations in the 13.75-14.0 GHz band with Federal Government operations through NTIA's FAS. FAS coordination will ensure that FSS earth stations do not interfere with receiving radiolocation stations, the TDRSS forward link-to-LEO, and the TDRSS receiving earth stations located at White Sands Complex, NM and Guam. We note that FSS earth stations that share spectrum with Federal Government operations are required to coordinate with the FAS to avoid interference problems to Federal Government receiving stations. Additionally, FSS entities will not be permitted to claim protection from radiolocation operations.

147. Finally, we adopt the same $EPFD_{up}$ limits for the 13.75-14.0 GHz band that we adopt for the 12.75-13.25 and 14-14.5 GHz bands, as contained in Section 25.208(h) of the Commission's Rules.[322] We find these limits are equally applicable to both bands because the sharing environments between NGSO FSS and GSO FSS systems are similar.

5. GSO FSS Gateway Uplink Bands: 14.4-14.5 GHz

148. *Current allocations.* In the *NPRM*, we noted that the 14.4-14.5 GHz band is allocated on a primary basis to FSS uplinks, and is primarily used for GSO operations, including VSATs. We also noted that the band is allocated on a secondary basis for land mobile satellite uplinks and Federal Government fixed and mobile operations, including use by the FAA and Qualcomm's Omnitracs tracking and data service.[323]

149. *Proposal.* In the *NPRM*, we proposed to allow NGSO FSS gateway uplinks to share the 14.4-14.5 GHz band with incumbent services. We requested comment on the appropriate technical requirements to enable such uplinks to share the band with GSO FSS uplinks and on the impact of the proposed NGSO FSS uplink operations on secondary uses of the band. We also requested comment as to whether NGSO FSS user terminals could be accommodated in the band.[324]

150. *Comments.* No party opposes NGSO FSS gateway uplink use of the 14.4-14.5 GHz band, and both Loral and SkyBridge support NGSO FSS user terminals being accommodated in the band. SkyBridge states that there is a need for additional spectrum for such user terminals, and notes that the

[322] *See* Appendix A.

[323] *NPRM* at ¶ 45.

[324] *Id.* at ¶ 46.

14.4-14.5 GHz band is neither allocated for co-primary FS use nor used by Federal Government radar operations on a secondary basis.[325] Loral argues that users terminals should be allowed to use the 14.4-14.5 GHz band because the band's current use is similar to that in the 14.0-14.4 GHz band – the only differences relating to secondary services.[326]

151. *Decision.* We find the $EPFD_{up}$ limits that we are adopting for the 12.75-13.15 GHz and 13.2125-13.25 GHz bands to permit sharing between GSO FSS uplinks and NGSO FSS gateway uplinks to be equally appropriate to permit such sharing in the 14.4-14.5 GHz band. We also find that permitting NGSO FSS gateway uplink use of the 14.4-14.5 GHz band will not adversely impact secondary uses of the band. Finally, we find persuasive SkyBridge's and Loral's contentions that also permitting NGSO FSS user terminal use of the band is desirable and will not create an unacceptable interference risk to incumbent users. Accordingly, we will permit NGSO FSS uplink use of the band by both gateways and user terminals.

6. NGSO FSS Gateway Uplink Bands: 17.3-17.8 GHz

152. *Current allocations.* In the *NPRM*, we noted that the 17.3-17.8 GHz band requested by SkyBridge for NGSO FSS gateway uplinks is allocated on a primary basis to FSS uplinks, but that US footnote US271 limits such operations in the United States to BSS[327] feeder link operations.[328] We further noted that the 17.7-17.8 GHz portion of the band is allocated on a primary basis to fixed operations, mobile operations, and FSS downlinks; that the 17.3-17.7 GHz portion is allocated for secondary Federal Government radiolocation operations; and that the entire 17.3-17.8 GHz band is allocated internationally for BSS downlinks in Region 2, but that this BSS allocation does not come into effect until April 1, 2007.[329]

153. *Proposal.* In the *NPRM*, we did not propose to permit NGSO FSS operations in the 17.3-17.8 GHz band.[330] We stated that coordination distances between NGSO FSS user terminals or gateways and ubiquitously deployed BSS receive earth stations would be prohibitively large.[331] Additionally, we stated that NGSO FSS operations at 17.3-17.7 GHz would be subject to extremely high e.i.r.p. radar transmissions from Federal Government radiolocation operations, and that interference from these radiolocation operations could be severe.[332] The *NPRM* also indicated that the Commission

[325] SkyBridge Comments at 21.

[326] Loral Comments at 10.

[327] BSS transmissions are downlinks to subscriber dishes that typically carry video programming. BSS feeder links are uplinks to BSS satellites and are performed in FSS allocations. Feeder links are used to send programming to the satellite for retransmission on BSS downlink frequencies.

[328] *NPRM* at ¶ 47.

[329] *Id.*

[330] *Id.* at ¶ 48.

[331] *Id.* at ¶ 50.

[332] *Id.* at ¶ 51.

proposed to implement the Region 2 BSS downlink allocation in the 17.3-17.7 GHz band domestically effective in 2007.[333]

154. *Comments*. EchoStar Communications Corporation ("EchoStar") states that it agrees with our proposal not to allocate the 17.3-17.8 GHz band to NGSO FSS service because that would jeopardize the flexibility and reliability of future BSS deployment in that band.[334] EchoStar contends that use of the band by NGSO FSS user terminals and gateways is not feasible in view of the international and proposed domestic allocation of that band to BSS downlinks starting in 2007, and that this conclusion is supported by ITU-R Document JTG 4-9-11/312.[335] EchoStar argues that even assuming that all NGSO FSS licensees are limited to a few gateways, with 3-5 NGSO FSS licensees there would still be many gateways located across the country. EchoStar further argues that the number of gateways would be increased by any foreign licensed NGSO FSS systems granted access to the U.S, and that any foreign gateways positioned close to U.S. borders could severely affect the provision of DBS services in the U.S. Additionally, EchoStar argues that the earliest the United States could object on interference grounds to any NGSO FSS gateways filed with the ITU would be 2002 when the ITU would first accept filings for BSS systems in the 17.3-17.8 GHz band. Moreover, EchoStar argues that the existence of gateways in 17.3-17.8 GHz band would also significantly increase the coordination burden on BSS operators, unduly constraining BSS operations, particularly when viewed in light of existing allocations.[336] Finally, EchoStar argues that NGSO FSS operations in the 17.3-17.8 GHz band would appear to interfere unacceptably with the Federal Government radiolocation service.[337]

155. DIRECTV, Inc. ("DIRECTV") strongly disagrees with SkyBridge's conclusion that NGSO FSS gateways can share the 17.3-17.8 GHz band with BSS user terminals.[338] DIRECTV argues that while use of this band may be feasible for BSS uplink use because there are expected to be only 6 BSS uplink sites across the United States, there could be many dozens and perhaps hundreds of gateway earth stations deployed by NGSO FSS operators.[339] DIRECTV contends that ITU-R document JTG 4-9-11/312 concludes that sharing between NGSO FSS and BSS user terminals is not possible, and that JTG 4-9-11 agrees with this assessment.[340]

156. SkyBridge asserts that the 17.3-17.8 GHz band is currently allocated and used for BSS feeder links, and that recent studies conducted by both U.S. and French Administrations as part of the JTG 4-9-11 process have shown that the separation distances between NGSO FSS gateways and BSS receive earth stations will be quite limited -- on the order of tens of kilometers.[341] SkyBridge further

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[333] *See* Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use, *Notice of Proposed Rule Making*, IB Docket No. 98-172, 13 FCC Rcd 19923 (1998) (18 GHz NPRM).

[334] EchoStar Comments at ii.

[335] EchoStar Reply Comments at 11.

[336] *Id.* at 12.

[337] *Id.* at 13.

[338] DIRECTV Reply Comments at 37.

[339] *Id.* at 38.

[340] DIRECTV Comments at 12.

[341] SkyBridge Comments at 19-20.

asserts that our proposed definition of a "gateway" and tight antenna patterns for gateways will limit their number and facilitate sharing with BSS.[342] SkyBridge also asserts that gateways are generally not located in heavily populated areas, and that in problematic cases natural and artificial shielding can be used to reduce the separation distances to a few kilometers.[343] Finally, SkyBridge asserts that promoting sharing between BSS and NGSO FSS will further Congress' mandate to expand access to interactive broadband services, especially in rural and remote areas.[344]

157. With respect to radiolocation operations, SkyBridge states that no commenter disputes the ability of NGSO FSS systems to coexist with radiolocation in the 17.3-17.8 GHz band.[345] SkyBridge maintains that operational coordination can take place between NGSO FSS and radiolocation systems to avoid prolonged exposure by NGSO FSS satellites to radar beams. SkyBridge states that it has proposed a footnote in the U.S. Table of Allocations, similar in concept to S5.502, that would preclude NGSO FSS systems from claiming protection from Federal Government radiolocation systems in the band, provided that both systems are operating within the requirements of the footnote.[346]

158. *Decision.* In the *Report and Order* in IB Docket No. 98-172, we allocated the 17.3-17.7 GHz band to the BSS on a primary basis, effective April 1, 2007.[347] While the Region 2 BSS allocation covers the entire 17.3-17.8 GHz band, we did not allocate the 17.7-17.8 GHz sub-band to BSS operations because of spectrum incompatibilities with existing terrestrial fixed operations in that band. We agree with EchoStar and DIRECTV that sharing of the 17.3-17.7 GHz band by ubiquitous BSS downlinks and NGSO FSS uplinks would be difficult. The resulting limitation on the location of BSS receive earth stations would be overly restrictive on ubiquitous BSS receivers. We also find that sharing of the 17.3-17.7 GHz band between the radiolocation and NGSO FSS operations would be problematic. Further, NTIA requests that the Commission not authorize any NGSO FSS operations in the 17.3-17.7 GHz band.[348] As we noted in the *NPRM*, the radiolocation service and GSO BSS feeder links are able to share this band only because radiolocation systems operate at powers of less than 51 dBW in the direction of the GSO arc. Satellites in other orbits could receive higher levels of interference, as radiolocation systems will be radiating indiscriminately in directions outside of the plane of the GSO arc in a manner that is not able to be predetermined or constrained in order to fulfill the functions of the radiolocation operation.[349] Accordingly, we decline to allocate the 17.3-17.8 GHz band to the NGSO FSS.

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[342] *Id.* at 20.

[343] *Id.*

[344] *Id.* at 20-21. Virgo also supports use of the 17.3-17.8 GHz band by NGSO FSS. *See* Virgo Reply Comments, at n.13.

[345] SkyBridge Reply Comments at 11.

[346] *Id.* at 10.

[347] *See* Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use, *Report and Order*, IB Docket No. 98-172, FCC 00-212, 65 FR 54155 (September 7, 2000).

[348] *See* Letter from William T. Hatch, IRAC Chairman, to Dale Hatfield, Chief, Office of Engineering and Technology, dated October 29, 1998.

[349] *NPRM* at ¶ 51.

B. NGSO Service Link Bands

1. NGSO FSS Service Downlink Bands: 11.7-12.2 GHz

159. *Current allocations.* In the *NPRM*, we noted that the 11.7-12.2 GHz band requested by SkyBridge for NGSO FSS service downlinks is allocated in the U.S. on a primary basis for FSS downlinks and is heavily used by television program distribution and VSAT operations. We also noted that mobile operations are permitted in the band on a secondary basis, but there are only a few mobile operations in the band.[350]

160. *Proposal.* In the *NPRM*, we proposed to permit NGSO FSS service downlink operations to share the 11.7-12.2 GHz band with incumbent GSO FSS downlinks, subject to sharing criteria. Specifically, we proposed sharing criteria similar to that proposed for the 10.7-11.7 GHz band, and sought comment on the adequacy of WRC-97 $EPFD_{down}$ limits for NGSO FSS operations to protect incumbent GSO FSS operations. We also requested comment regarding sharing with GSO FSS large aperture earth stations, inclined orbit satellites and TT&C links.[351]

161. *Decision.* As we noted in the *NPRM*, the sharing scenario in the 11.7.-12.2 GHz band raises issues similar to those regarding NGSO FSS gateway downlinks in the 10.7-11.7 GHz band. For the reasons discussed above, we adopt the same $EPFD_{down}$ limits for NGSO FSS service downlinks in the 11.7-12.2 GHz band that we are adopting for NGSO FSS gateway downlinks in the 10.7-11.7 GHz band. While NGSO FSS service downlink stations will be ubiquitously deployed and will have different antenna characteristics than the gateway downlink stations, the $EPFD_{down}$ limits were developed to address both types of operations. We also conclude that since NGSO FSS gateway stations will be operating using the same $EPFD_{down}$ limits as NGSO FSS user earth station, NGSO FSS gateway earth station may operate in this 11.7-12.2 GHz band. In addition, we adopt the same coordination procedures to protect GSO FSS networks using sensitive receiving earth stations with very large antennas, as discussed above.[352]

2. NGSO FSS Service Downlink Bands: 12.2-12.7 GHz

162. *Current allocation.* In the United States, the 12.2-12.7 GHz band is allocated on a primary basis to BSS for use by DBS systems. While the band has a primary allocation for the FS, fixed systems licensed in the band after September 9, 1983 must operate on a non-harmful interference basis to the BSS.[353]

163. *Proposal.* In the *NPRM*, the Commission proposed to allocate the 12.2-12.7 GHz band on a co-primary basis to the NGSO FSS for use by service downlinks.[354] The *NPRM* indicated that it appears that spectrum sharing in this band is possible between BSS and NGSO FSS.[355] In order to ensure protection of DBS, while accommodating new NGSO FSS services, we sought comment on the WRC-97

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[350] *Id.* at ¶ 53.

[351] *Id.* at ¶¶ 53-54.

[352] *See supra*, ¶ 111.

[353] *See* 47 C.F.R. § 101.147(p).

[354] *NPRM* at ¶ 52.

[355] *Id.*

provisional EPFD limits contained in Table S22-1 of the Radio Regulations.[356] The Commission stated that it was not convinced that the WRC-97 provisional limits were adequate to protect DBS, noting, however, that there was no alternative before us at that time. We also stated that NGSO FSS operations should not hinder the evolution of DBS.

164. The *NPRM* also requested comment on a petition from Northpoint to allow terrestrial retransmission of local television signals and data services to DBS receivers in the 12.2-12.7 GHz band on a non-interference basis to BSS operations.[357] Northpoint argues that its proposed service, which we refer to herein as the MVDDS, would allow DBS subscribers to receive local television programming and data services with minimal additional equipment and thus would permit the DBS service to compete more fully with cable television services.[358] To permit sharing with DBS operations, which features earth stations pointed southward to receive signals from GSO BSS satellites located over the equator, Northpoint would use northward pointing receivers at a DBS subscriber's location to receive signals transmitted from terrestrial towers whose directional antennas point southward. Northpoint indicates that the return link from subscribers to achieve full two-way data services will be achieved on other spectrum or by using existing wireline networks. While recognizing the potential benefits of the Northpoint proposal, we stated that the concerns of DBS licensees require us to approach cautiously this type of operation in the DBS band. The *NPRM* also sought further technical analyses on Northpoint's ability to share spectrum with DBS.[359] Finally, we sought comment on whether a Northpoint-type service is desirable to satisfy DBS subscribers' local programming needs.[360]

165. *Decision.* We note that an extensive record has been filed concerning spectrum sharing in the 12.2-12.7 GHz band by NGSO FSS, BSS and MVDDS operations, and interested parties subsequently reached a compromise solution to NGSO FSS and BSS sharing issues at the CPM, which was ultimately adopted at WRC-2000.[361] We thus find that we have an adequate record to make decisions on future NGSO FSS, MVDDS and BSS operations in the 12.2-12.7 GHz band.

166. As discussed below, we conclude that NGSO FSS operations can share this band with BSS operations on a co-primary basis under certain technical operating parameters, which we adopt herein. Throughout this proceeding, we have focused on the ability of NGSO FSS operations to coexist with existing operations in several spectrum bands without causing unacceptable interference to those

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[356] *Id.* at 59.

[357] *Id.* at ¶ 8. Northpoint filed its Petition for Rule Making requesting the establishment of this service in March 1998. That petition was designated RM-9245, and was placed on public notice on March 23, 1998. *See Public Notice*, Report No. 2265.

[358] *NPRM* at ¶ 8. We note that Northpoint originally proposed its service as a supplement to DBS operations in the 12.2-12.7 GHz band. Subsequently, on January 8, 1999 Northpoint and its affiliates filed terrestrial license applications for the 12.2-12.7 GHz band covering the entire United States under the name Broadwave. In Northpoint's March 2, 1999 comments it argues that its proposed service and associated applications could provide nationwide video and data services and ignite competition to cable and other multichannel video program distributors. *See* Northpoint Comments at Summary.

[359] *Id.* at ¶ 95.

[360] *Id.* at ¶¶ 91-92.

[361] We note that the 12 GHz DBS service is in an ITU "planned band" and is based on using analog receivers. The ITU-R recommends similar noise allocations as the GSO FSS networks for digital DBS using the planned band assignments.

services. Although the spectrum management policies concerning spectrum sharing are complex, the results are worthwhile because we can allow the deployment of new services, achieve more and efficient use of a finite amount of spectrum, and ensure the protection of incumbent operations. Accordingly, we are allocating the 12.2-12.7 GHz band to the fixed satellite service for use by non-geostationary orbit satellite downlink operations on a co-primary basis. This action will be implemented domestically through the adoption of footnote S5.487A into our Table of Frequency Allocations. This footnote allocation for NGSO FSS operations in the 12.2-12.7 GHz band was established at WRC-1997 and modified at WRC-2000, and we find that it should facilitate the delivery of advanced services to the United States, as well as to other countries.

167. We also conclude that MVDDS can operate in the 12.2-12.7 GHz band under the existing FS allocation. Under this allocation, as discussed below, MVDDS operations would not be permitted to cause harmful interference to the BSS and would operate on a co-primary basis to NGSO FSS. We find that the public interest would be served by allowing MVDDS operations in this band. MVDDS could be used to deliver a wide array of video programming, including local television, and data services on either a competitive or sole source basis in both urban and rural areas. While MVDDS will only be permitted to use the 12.2-12.7 GHz band for transmissions to its subscribers, we find that full two-way services can be achieved using spectrum in other bands or existing wireline networks for the return link. Terrestrial MVDDS systems would intensively reuse available spectrum, allowing for efficient use of the band. Furthermore, it is feasible to avoid or correct harmful interference situations between MVDDS and DBS or between MVDDS and NGSO FSS. As discussed below, spectrum sharing will necessitate some restrictions on MVDDS antenna locations and transmitter power levels in order to avoid interference to DBS, and could require coordination with some NGSO FSS systems. In our Further Notice of Proposed Rule Making, we make several specific proposals regarding MVDDS technical, service and licensing rules.

168. Some commenters question whether the 12.2-12.7 GHz band is appropriate for MVDDS operations.[362] The 12.2-12.7 GHz band is particularly attractive both because MVDDS equipment can take advantage of the economies of scale that already exist for electronics and antennas that use this band[363] and because the band offers sufficient spectrum to offer a service that can compete with cable television and DBS services. Alternative bands, such as the 2596-2644 MHz Multichannel Multipoint Distribution Service and the 27.5-31.3 GHz Local Multipoint Distribution Service, are not as attractive. These bands either do not offer the same amount of spectrum, are encumbered by existing operations, impose higher equipment costs, or have significant propagation constraints. The use of innovative spectrum sharing techniques will facilitate a high level of frequency reuse in this band and provide a variety of broadband services to a vast number of customers.

169. In the discussion below, we first address our decision to provide a co-primary allocation for NGSO FSS in this band and to require certain technical operating parameters for NGSO FSS in order to facilitate spectrum sharing with incumbent BSS operations. We then address our decision to allow MVDDS operations in this band and how this fixed service can share spectrum with incumbent BSS operations and new NGSO FSS operations.

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[362] DIRECTV contends that Northpoint has not demonstrated why it requires the 12.2-12.7 GHz band for its proposed service, and asserts that other spectrum is available. DIRECTV Comments at 4-7.

[363] Northpoint maintains that its technology requires deployment in the 12.2-12.7 GHz band because it was designed specifically to use existing commercially available consumer and transmission equipment in that band. Northpoint Reply Comments at i-iv, 1-2.

a. NGSO FSS sharing with BSS

170. After evaluating the extensive record in this proceeding, including the work of the ITU-R study groups and WRC-2000, we find that the agreements reached in these international meetings provide the basis to allow NGSO FSS operations to share successfully the 12.2-12.7 GHz band with BSS operations without causing unacceptable interference. The results of the technical studies have been included in the Final Acts of WRC-2000 and represent the most comprehensive and current studies on NGSO FSS and BSS co-frequency operations to date. We conclude that these criteria, which provide for both single entry and aggregate $EPFD_{down}$ limits for NGSO FSS operations, are appropriate for protecting GSO BSS operations in the United States, and we will adopt both types of limits. The single-entry $EPFD_{down}$ limits are those that a single NGSO FSS system will have to meet. These single-entry limits, combined with a method to address the aggregate interference from all NGSO FSS systems in the band, will ensure protection of GSO BSS operations from NGSO FSS interference.

171. Both single entry and aggregate $EPFD_{down}$ limits consist of two elements: (1) a set of "validation" $EPFD_{down}$ limits (mask) which include additional latitude-dependent "validation" $EPFD_{down}$ limits not to be exceeded for 100% of the time for 180 cm, 240 cm and 300 cm BSS earth station antennas; and (2) an "operational" $EPFD_{down}$ limit not to be exceeded for 100% of the time for 240 cm BSS earth station antennas located in Alaska. As discussed in more detail below, in order to receive a favorable finding internationally,[364] each NGSO FSS system must not exceed the single-entry validation $EPFD_{down}$ limits using the ITU-BR software.[365] The ITU BR will not verify that NGSO FSS systems comply with the operational limits; rather, individual Administrations and their GSO FSS system operators would determine whether an NGSO FSS system is exceeding the operational $EPFD_{down}$ limits. Also, we are adopting additional technical criteria for NGSO FSS systems to protect 180 cm BSS receivers, although it was not included in the international agreements.

172. We find that the single-entry and aggregate $EPFD_{down}$ limits we are adopting will not unduly hinder the growth of BSS, as proposed in the *NPRM*.[366] As discussed in more detail below, the ITU-R considered future BSS systems and examples of advanced technology BSS links (*e.g.*, 8PSK digital modulation and improved receiver temperature of 80 degrees Kelvin) to develop $EPFD_{down}$ limits for NGSO FSS.[367] In addition, future BSS systems will be able to take into account the NGSO FSS interference environment.[368]

173. In the following sub-sections, we discuss particular issues with respect to NGSO FSS operations in the 12.2-12.7 GHz band, such as single-entry $EPFD_{down}$ limits, verification of compliance

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[364] Compliance with the "validation" limits will be checked by the ITU/BR under Radio Regulation No. S9.35 and S11.31. *See also* Section 3.1.2.4.6 of the CPM Report.

[365] ITU-R Recommendation BO.1503 provides the specification for the software that the BR/ITU would use to verify that a NGSO network meets the EPFD limits.

[366] *NPRM* at ¶ 58.

[367] DIRECTV insists that the Commission ensure that any $EPFD_{down}$ limits adopted fully protect the examples of future BSS links contained in the ITU database, in order to preserve the ability of BSS systems to innovate. DIRECTV Reply Comments of at 37.

[368] *See, e.g.,* SkyBridge Comments at 64 (SkyBridge asserts that future systems, as opposed to existing systems, can plan for the NGSO FSS environment, and take such systems into account in developing link budgets for future BSS systems).

with the validation limits, operational $EPFD_{down}$ limits to protect larger BSS receive earth station antennas, and aggregate NGSO FSS interference levels.

(i) Single-Entry $EPFD_{down}$ Limits

174. *Proposal.* In the *NPRM*, we sought comment on the WRC-97 provisional single-entry limits, and also expressed our concern that these limits were not adequate to protect BSS.[369] We indicated that if the record developed in this proceeding demonstrates that these limits are not appropriate to protect DBS services, we would explore alternative limits.

175. *Comments.* Some commenters expressed concern that the WRC-97 provisional limits would not protect the widely deployed 45 cm DBS dishes, or the larger DBS dishes deployed in rural and remote areas, and that the provisional limits would hinder the evolution of DBS operations.[370] Several parties even made various proposals for alternative $EPFD_{down}$ limits. Nonetheless, all parties urge that the ITU-R agreed upon interference criteria and internationally compiled database of GSO BSS links be used to establish BSS protection limits.[371] SkyBridge fully supports the technical agreements reached at the CPM, and no other parties opposed the technical agreements.[372] Boeing urges the Commission to adopt the compromise agreement reached at the CPM without deviation. It argues that this would foster the development of universally-available telecommunications services by creating globally-consistent regulatory requirements.[373]

176. *Decision.* We find, based upon the technical work within the ITU, and the record developed in this proceeding, that the international consensus single-entry $EPFD_{down}$ limits for 30 cm, 45 cm, 60 cm, 90 cm, 120 cm, 180 cm, 240 cm and 300 cm diameter BSS earth station antennas are appropriate for protection of GSO BSS systems in the United States.[374] Specifically, the combination of the two elements comprising these limits (*i.e.*, validation including latitude-dependent, and operational) adequately protect the U.S. BSS systems. We adopt these limits as new rule Section 25.208(i) of the Commission's Rules contained in Appendix A of this First R&O.

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[369] *NPRM* at ¶ 59.

[370] EchoStar Reply Comments at 5-6 and Boeing Reply Comments at 13.

[371] *See, e.g.*, SkyBridge Comments at 58-59, DIRECTV Comments at 9, DIRECTV Reply Comments at 35, and EchoStar Reply Comments at 7.

[372] SkyBridge Supplemental Comments at ii-iii. Some commenters, such as DIRECTV, did express concern about certain aspects of the agreement, such as the implementation of operational limits, or proposed additional provisions, such as an additional limit for 180 cm BSS earth station antennas in Alaska. DIRECTV Supplemental Comments at 9, 10-12.

[373] Boeing Supplemental Comments at 3.

[374] We are including $EPFD_{down}$ limits for 30 cm and 300 cm diameter BSS earth station antennas, although there is no requirement for BSS earth station antennas of these sizes in the United States. No representative from the BSS industry proposed $EPFD_{down}$ limits for 30 cm or 300 cm diameter BSS earth station antennas, nor are such antennas in use in the United States. *See, e.g.*, DIRECTV Comments at 9. If a DBS entity wishes to implement BSS earth station antennas of this diameter in the United States, they would have to specify this antenna size in their application for a DBS authorization. The Commission would review the technical information submitted with the application, and determine if such operations can be accommodated within the interference environment in the United States. For example, 30 cm BSS earth station antennas may not be compatible with the BSS Plan assignments of other Administrations.

177. These limits were developed using the agreed upon criteria and the international database of GSO BSS links both developed by the ITU-R. This was also the approach that the commenters recommended we use to establish the appropriate $EPFD_{down}$ limits.[375] As an initial matter, the ITU-R compiled characteristics of the BSS systems to be taken into account in sharing studies with NGSO FSS systems.[376] The United States submitted characteristics of its existing and planned GSO BSS systems to be included in these studies. In addition, the ITU-R developed recommended criteria to be used in developing acceptable $EPFD_{down}$ limits to protect GSO BSS.[377] The ITU agreed upon criteria consists of two parts: (1) the aggregate interference from NGSO FSS systems should be responsible for at most 10% of the time allowance(s) for unavailability of the GSO BSS network; and (2) the aggregate interference from NGSO FSS systems should not lead to the loss of video picture continuity in the GSO BSS network. This criteria will be referred to herein as the "agreed upon criteria." During the development of the $EPFD_{down}$ limits, a proposed set of $EPFD_{down}$ limits was tested against this international database of GSO BSS links to determine if the agreed criteria was met, and therefore whether the proposed $EPFD_{down}$ limits are appropriate. Using the agreed upon criteria and the database of GSO BSS links, the ITU-R was able to reach consensus on both the single-entry and aggregate $EPFD_{down}$ limits.

178. With these $EPFD_{down}$ limits, most BSS links are protected to the agreed upon protection level.[378] For example, all of the links in areas in which 45 cm antennas are used almost exclusively (the majority of the United States), are protected to the agreed upon level.[379] However, as the antenna size increases, there are some BSS links that are not protected to the agreed upon level.[380] In these specific cases where the agreed upon protection level was not provided by the proposed $EPFD_{down}$ limits,[381] the affected Administration agreed to the level of exceedance, prior to these $EPFD_{down}$ limits becoming finalized. This was the process used for any U.S. submitted links where the agreed upon criteria was not met. In addition, the ITU-R ensured that NGSO FSS was not unduly constrained in developing these limits. For example, the shape of the $EPFD_{down}$ curve was chosen to accommodate planned NGSO FSS systems.[382] Also, the use of operational limits in place of validation limits for certain situations, avoids undue constraints on NGSO FSS due to the conservative nature of the ITU validation software. Below we discuss the importance of each of the three elements that comprise these limits.

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[375] DIRECTV Reply Comments at 35, 37; and EchoStar Reply Comments at 7.

[376] ITU-R circular letters CR/92 and CR/116 requested that Administrations submit information on their existing and planned GSO BSS systems. The compiled set of GSO BSS system characteristics is contained as an Annex to ITU-R Recommendation BO.1444. Hereinafter, we refer to this set of compiled GSO BSS system characteristics as the "international database of GSO BSS links."

[377] The criteria is contained in draft new Recommendation ITU-R BO.1444. In addition, the criteria is described in Section 3.1.3.1 of the CPM report to WRC-2000.

[378] Annex 11 (Preliminary draft new report: Derivation of $EPFD_{down}$ Limit Masks) to Document 10-11s/209-e, dated 16 June 1999, the Chairman's Report of the Third Meeting of JWP 10-11s, Geneva, 19-28 May, 1999.

[379] *Id.*

[380] *Id.* For example for 90 cm diameter GSO BSS earth station antennas, 3 links are not protected to the first criterion, the 10 % increase in BSS link unavailability.

[381] Section 4 ("Further Work") of Annex 1 to Appendix 1 of the Chairman's Report of the Third Meeting of JTG 4-9-11 (Long Beach, USA, 19-29 January 1999) (Document 4-9-11/367-E, dated 5 February 1999).

[382] Section 3.1.3.1.4 (b) of the CPM Report, and *recommends* 3.2 of draft new Recommendation ITU-R BO.1444.

179. The first set of limits, the "validation" $EPFD_{down}$ limits ensure appropriate protection of smaller GSO BSS earth station antennas, those ranging from 30 cm to 120 cm in diameter. The ITU-BR will test these validation $EPFD_{down}$ limits using the ITU-BR software. To protect larger GSO BSS earth station antennas, the latitude dependent "validation" limits (for 180 cm, 240 cm and 300 cm diameter GSO BSS earth station antennas), and the "operational" limit for 240 cm GSO BSS earth station antennas are needed to supplement the validation $EPFD_{down}$ limits. These limits provide additional protection against loss of video picture continuity, and limit the increase in unavailability, for these larger GSO BSS earth station antennas. Due to their higher on-axis gain, larger earth station antennas are more susceptible to the short term interference[383] that can lead to the loss of video picture continuity.

180. The latitude-dependent "validation" $EPFD_{down}$ limits will provide additional protection to GSO BSS earth stations located in high latitude regions such as Alaska. The latitude-dependent validation $EPFD_{down}$ limits apply to 180 cm, 240 cm and 300 cm BSS earth station antennas. These limits become more stringent on NGSO FSS systems as the latitude of the GSO BSS earth station increases over 57.5 degrees North or South. At a high latitude location, BSS earth stations can be located at the edge of the coverage area of the GSO BSS satellite and receive lower downlink e.i.r.p. and are therefore more susceptible to NGSO FSS interference. In addition, GSO BSS links operating at higher latitudes have lower elevation angles to the GSO BSS satellites and a longer path length that also results in a lower e.i.r.p. at the earth station.[384] Thus, tighter latitude-dependent validation limits provide greater protection to BSS, while not unduly constraining NGSO FSS.

181. The operational $EPFD_{down}$ limit for 240 cm BSS earth station antennas ensures protection of 240 cm diameter BSS earth station antennas currently in use in Alaska. The limit applies to receive BSS earth station antennas located in Alaska that use elevation angles greater than 5° and that point toward BSS satellites at the following orbit locations: 91° W.L., 101° W.L., 110° W.L., 119° W.L. and 148° W.L. We recognize that there are restrictive international power limits on GSO BSS to protect terrestrial services in adjacent countries.[385] These restrictive power limits require a lower e.i.r.p. from BSS satellites towards the geographic areas requiring the use of larger GSO BSS receive earth station antennas in Alaska. These particular links require more stringent $EPFD_{down}$ limits for protection from interference from NGSO FSS systems. This is because of the limited downlink e.i.r.p. and large antenna diameter of these links. More stringent limits, however, are more difficult for NGSO FSS systems to meet.[386] The operational limits were developed to provide additional protection to GSO BSS 240 cm earth

[383] Short term interference occurs for very short periods of time and is caused by NGSO FSS satellite antenna side lobe interfering into the GSO BSS receive earth station antenna mainbeam. The sidelobes of an antenna are areas outside of the mainbeam (*i.e.*, main/desired pointing direction of the antenna) and an antenna has lower gain in its sidelobes than in the mainbeam.

[384] Many NGSO FSS systems are designed in such a way that their power naturally decreases at these high latitudes that are located outside of high population areas. Also, Document 4-9-11/245-E (from France, dated 13 January 1998) demonstrates that F-SATMULTI-1B satellites whose sub-satellite points are greater than 40° latitude will have a much lower PFD versus satellites whose sub-satellite point is less than 40° latitude.

[385] These limits are contained in Section 5c) of Annex 1 to Appendix S30 of the ITU Radio Regulations (Edition 1998). *See* U.S. input document to the CPM, Document CPM99-2/29 and its corrigendum, *see also* Policies and Rules for the Direct Broadcast Satellite Service, *Notice of Proposed Rule Making*, 13 FCC Rcd. 6907, 6934 (1998) ("DBS NPRM").

[386] As noted in the comments, the ITU software validation tool may be overly conservative so that it hinders efforts to arrive at $EPFD_{down}$ limits acceptable to all parties. In particular, NGSO FSS interests may have to add significant margins to the limits to ensure that their systems can pass. DIRECTV Reply Comments at 32. SkyBridge Comments at 38, 94-97. STA Comments at 8.

station antennas in Alaska, while not unduly constraining NGSO FSS by requiring validation with the ITU software tool.

182. In addition, WRC-2000 indicated that this operational limit may be applied for a transition period.[387] Because the restrictive power limits that result in the use of the larger BSS earth station antennas in Alaska were sufficiently relaxed by WRC-2000, we will also adopt a transition period for the implementation of operational $EPFD_{down}$ limits for the 240 cm earth stations in the United States operating north of 60 degrees latitude, *e.g.*, Alaska. Although DIRECTV argues that the transition period should be 17 years instead of 15,[388] we conclude that 15 years is an appropriate amount of time for the operational limits to be in effect. Fifteen years is an adequate representation of the life of a satellite today. Further, a 15-year transition period will further promote our goal of encouraging the use of smaller BSS earth station antennas in Alaska. Therefore, the 15-year transition period will be included in our rules and the operational limits will no longer apply to NGSO FSS operators fifteen years from the effective date of the rules in this First R&O.

183. DIRECTV argues that we should not require the $EPFD_{down}$ limit from the international consensus for 180 cm BSS earth station antennas in Alaska, but rather apply a different limit to protect these stations. While the latitude dependent validation $EPFD_{down}$ limits apply to 180 cm BSS earth station antennas, the CPM agreement includes an operational limit only for 240 cm BSS earth station antennas. DIRECTV asserts that the high latitude 100%-of-the-time $EPFD_{down}$ limit of -163.1 dB(W/m^2/40 kHz) does not protect DIRECTV services using 180 cm BSS earth station antennas in the Anchorage area, and requests that the operational limit of –167 dB(W/m^2/40 kHz) be implemented for 180 cm BSS earth station antennas.[389] Further, DIRECTV states that because an NGSO FSS system must meet this limit for 240 cm BSS earth station antennas, it will automatically meet this limit for 180 cm BSS earth station antennas and thus would place no additional constraints on NGSO FSS systems. Boeing urges the Commission not to deviate from the agreements reached at the CPM.[390]

184. As previously noted, we are committed to ensuring the provision of BSS to all of the United States, including Alaska.[391] We are adopting specific rules to protect BSS to Alaska from NGSO FSS interference, such as operational limits for 240 cm BSS earth station antennas in Alaska. This specific provision was based on significant technical work performed in the ITU-R, such as agreements contained in the CPM Report and Final Acts of WRC-2000, and based on the GSO BSS links submitted by the United States for inclusion in the international database of GSO BSS links. We do not find that DIRECTV provides sufficient technical justification for requiring an operational limit of –167 dB(W/m^2/40 kHz) in Alaska.[392] Further, DIRECTV's concerns are alleviated by how we are implementing the operational limits

[387] Footnote 25 to Table S22-4C of the Provisional Final Acts specifies that the operational limit may be implemented for a transition period of 15 years if the PFD limits in Section 5c) of Annex 1 to Appendix S30 are sufficiently relaxed; DIRECTV Supplemental Comments at 9.

[388] DIRECTV Supplemental Comments at 9.

[389] *Id.* at 10-12.

[390] Boeing Supplemental Comments at 3.

[391] Section 100.53, 47 C.F.R § 100.53, of the Commission's Rules requires that DBS licensees provide service to Alaska and Hawaii. *See also* Policies and Rules for the Direct Broadcast Satellite Service, *Notice of Proposed Rule Making,* 13 FCC Rcd. 6907, 6926 (1998).

[392] This requirement is not supported by the GSO BSS links that the United States supplied to the ITU-R, nor does DIRECTV provide complete information in its comments on the BSS links to Alaska that justifies this value. In (continued....)

in the United States. We are requiring NGSO FSS applicants to demonstrate that they meet the operational limits at test points that represent the worst case scenario, everywhere in Alaska (or the entire United States, as the case may be) all of the time. Therefore, as DIRECTV points out, the 180 cm BSS earth station antennas will effectively not receive greater interference than the –167 dB(W/m^2/40 kHz) value by virtue of the operational 100%-of-the-time limit we adopt for 240 cm BSS earth station antennas in Alaska. Contrary to the implementation of operational limits internationally, the burden is not entirely placed on the GSO BSS operator to monitor the NGSO FSS interference into its operational earth stations and if the operational limits are exceeded in practice, request that the interference be restored to levels below the operational limits.[393] Considering the foregoing, we conclude that there is not sufficient information in our domestic proceeding to warrant adopting an additional requirement on NGSO FSS systems to protect 180 cm BSS earth station antennas in Alaska.

185. *Protection of 180 cm BSS earth station antennas in Hawaii.* The international consensus $EPFD_{down}$ limits may not ensure adequate protection to all BSS earth station antennas in Hawaii, as the additional validation and operational limits are only for regions located in high latitudes. We note that EchoStar provides BSS to Hawaii using 180 cm diameter or larger earth station antennas. These links require greater protection than is afforded by the validation limits that we are adopting above.[394] Although the U.S. had proposed a tighter $EPFD_{down}$ limit in the international meetings over Hawaii for 180 cm BSS earth station antennas,[395] two of the interested parties – SkyBridge and EchoStar – agreed that in lieu of a specific international regulation to protect operations in Hawaii, to submit a joint letter to the Commission detailing agreed-upon limits, for inclusion in our domestic rules. Specifically, the joint letter proposes a "never-to-be-exceeded-in-operation" (*i.e.*, operational, not to be exceeded for 100% of the time) $EPFD_{down}$ limit of –162.5 dBW/m^2/40 kHz over Hawaii for GSO BSS receive earth station antennas pointing towards any current EchoStar satellite operating in the 110° W.L., 119° W.L. and 148° W.L. nominal orbital positions, in addition to the $EPFD_{down}$ limits specified in Annex 1 to the letter.[396] The limits in Annex 1 to the letter are the same as those contained in the CPM Report and Final Acts.

186. In addition, it appears upon initial review, that the other NGSO FSS systems on file will not cause such short term interference and therefore should not have any difficulty meeting the limit agreed to by SkyBridge and EchoStar. We will, therefore, adopt the SkyBridge/EchoStar agreement for 180 cm BSS earth station antennas in Hawaii into our rules.[397] We will implement this operational limit in the same manner as the operational limit to protect 240 cm BSS receive earth station antennas.[398] Any NGSO FSS system that provides service to the United States – even systems that are not licensed by the United States – will have to meet this limit over Hawaii.

(Continued from previous page)
addition, the value of downlink e.i.r.p. to Anchorage that DIRECTV specifies in its comments is not supported by DIRECTV's DBS satellite applications submitted to the Commission.

[393] Section 3.1.2.4.7 of the CPM Report.

[394] EchoStar asserts it needs greater protection. See Document CPM99-2/29 + Corr. 1.

[395] Document CPM99-2/29 + Corr. 1.

[396] Letter from Jeffrey Olson, Attorney for SkyBridge L.L.C. to Magalie Roman Salas, Secretary, dated December 30, 1999, and Attachment.

[397] *See* new Section 25.208(i) and (j) in Appendix A.

[398] *See* new Section 25.145(b)(2).

187. *BSS receive earth station antenna patterns.* The BSS receive earth station antenna pattern is an important component in the assessment of interference from NGSO FSS satellites into GSO BSS earth station antennas. In the *NPRM*, we recognized that off-set feed receive earth station antennas may have different discrimination characteristics in directions other than the plane of the geostationary satellite orbit.[399] The ITU-R studied the appropriate BSS receive earth station antenna patterns to use in its interference studies and developed a recommended antenna pattern, which is used in the definition of the $EPFD_{down}$ limits, to protect BSS earth stations. This pattern was included in the Final Acts of WRC-2000 and will be used in calculating whether or not a given NGSO FSS system complies with a certain $EPFD_{down}$ limit.[400] The antenna pattern takes into account the transient nature of NGSO FSS interference, and reflects an averaging of the peaks and valleys of an actual GSO BSS earth station antenna pattern, instead of providing a conservative envelope of the peaks of the sidelobes. No party has objected to the use of this new antenna pattern in the international process, or within this domestic proceeding. Accordingly, we will include this new receive earth station antenna pattern in the definition of $EPFD_{down}$ limits to protect BSS receive earth stations in our rules. We note, however, that BSS earth station antennas whose actual antenna performance is worse than predicted by this antenna pattern will receive more interference from NGSO FSS than antennas that meet or perform better than the recommended pattern. Although we will not require DBS providers to use this new pattern, we strongly encourage DBS licensees and applicants to take this new pattern into account in designing their future systems.

(ii) Domestic Implementation of Single-Entry $EPFD_{down}$ Limits

188. *Proposal.* In the *NPRM*, we recognized that domestically we must ensure that all NGSO FSS licensees satisfy the EPFD limits.[401] We stated that the Commission needs to verify that a proposed system meets the appropriate limits for domestic licensing purposes, as well as to confirm information that will be sent to the ITU. Commenters agree that the single entry PFD limits should be strictly enforced.[402]

189. *Decision.* As discussed below, we are adopting implementation procedures for single-entry validation and latitude-dependent validation limits, and a separate set of procedures for operational limits. In addition to ensuring protection of BSS, this will assist the Commission in its need to confirm to the ITU that the appropriate limits are being met. Many of the implementation procedures we discuss below are similar to the procedures we adopt to protect GSO FSS networks from NGSO FSS.

(iii) Domestic Implementation of Single-Entry Validation and Latitude-Dependent Validation Limits

190. DIRECTV encourages the Commission to carefully consider the functional description of the validation software, as additional problems may be yet uncovered.[403] SkyBridge, Loral, Boeing, and STA support the use of a commonly accepted software tool, such as that being developed by the ITU-R, to ensure compliance with the EPFD limits.[404] Boeing, however, states that the Commission should not

[399] *NPRM* at ¶ 58.

[400] These new antenna patterns are found in Annex 1 to Recommendation ITU-R BO.1443 *See* Table S22-1D and note 14 of Article S22, of the Final Acts. The software functional description is contained in ITU-R Recommendation BO.1503.

[401] *NPRM* at ¶ 80.

[402] *See e.g.,* DIRECTV Reply Comments at 34 and DIRECTV Supplemental Comments at 12.

[403] DIRECTV Supplemental Comments at 14.

[404] Loral Comments at 19, SkyBridge Comments at 93, Boeing Comments at 84, and STA Comments at 8.

adopt any one software tool until all of the various software tools that have been developed have undergone further analysis.[405] STA agrees that we should adopt a validation process for domestic use and require NGSO FSS applicants to disclose the requisite system parameters and provide any software elements necessary to supplement the core validation software.[406]

191. As with the validation limits adopted to protect GSO FSS operations, in order to receive a favorable finding internationally,[407] each NGSO FSS system must not exceed the specified validation $EPFD_{down}$ limits when analyzed using the ITU-BR software. We believe that it is imperative that NGSO FSS compliance with the single entry validation $EPFD_{down}$ limits be verified during the domestic licensing process. For the same reasons discussed in the section above on validation $EPFD_{down}$ limits to protect GSO FSS operations, we will also require an NGSO FSS applicant to demonstrate prior to licensing that it meets the validation $EPFD_{down}$ limits to protect GSO BSS operations.[408] Despite DIRECTV's concern about potential problems with using the functional description of the ITU-BR validation software, we will require the NGSO FSS applicants to use the software developed in accordance with the ITU software specification contained in the ITU-R Recommendation BO.1503. This software has been thoroughly evaluated by the ITU-R, including by U.S. participants in the ITU-R groups.[409] The specific information we will require from the NGSO FSS applicants is described in detail in the GSO FSS section and new rule Section 25.146(a)(1).[410]

(iv) Domestic Implementation of $EPFD_{down}$ Operational Limits

192. The operational limit is included in Article S22 of the ITU-R Radio Regulations and unlike the validation limits, the ITU-BR will not verify compliance of NGSO FSS systems with this limit.[411] Individual Administrations and their GSO system operators would determine whether a NGSO FSS system is exceeding the operational EPFD limit. If an operating NGSO FSS system exceeds the operational limit into an operating GSO BSS receive earth station, the NGSO FSS network would have to take all necessary steps, as expeditiously as possible, to ensure that the interference caused to the GSO BSS receive earth station is restored to levels at or below the operational EPFD limit. WRC-2000 did not adopt specific procedures to ensure compliance with operational limits; instead, these procedures will be developed within the ITU-R and addressed at the next WRC.[412]

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[405] Boeing Comments at 84.

[406] STA Comments at 8.

[407] Section 3.1.2.4.6 of the CPM Report. Compliance with the "validation" limits will be checked by the ITU/BR under Radio Regulation No. S9.35 and S11.31.

[408] These limits are defined in ITU-R Recommendation BO.1503.

[409] The functional description was finalized by the JTG 4-9-11 at its May/June 1999 meeting. JWP 10-11S further reviewed several aspects at its October 1999 and WP4A reviewed it at its February 2000 meeting.

[410] *See* Appendix A

[411] Section 3.1.2.4.7 of the CPM Report to WRC-2000.

[412] Resolution [COM5/6] (WRC-2000). The CPM recognized that in order to implement the operational limit concept, a procedure is needed which: i) identifies non-GSO systems exceeding the operational limits; and ii) ensures immediate reduction of the interference level to the operation limits by any non-GSO system exceeding those limits.

193. *Comments.* Commenters addressed both the type of information the Commission should require in order to confirm that an NGSO FSS operator will operate in compliance with the operational limit and the appropriate time for providing this information to the Commission. DIRECTV, while not objecting to the operational limit of –167 dB(W/m^2/40 kHz), urges the Commission, as part of its NGSO licensing procedure, to ascertain through computer simulation that the NGSO FSS system will meet all $EPFD_{down}$ limits, regardless of whether they are considered by the ITU-R to be "validation" limits or "operational" limits.[413] Specifically, DIRECTV submits that NGSO FSS applicants must be required to provide sufficient information to the Commission so that the agency or a third party can perform simulations to verify that the operational limits will be met. PanAmSat states that the international agreement envisions that individual Administrations will determine compliance with, as well as, enforce the operational limits.[414] SkyBridge, on the other hand, believes that requiring NGSO FSS applicants to demonstrate compliance with operational limits as part of the licensing process is not consistent with the principle behind the operational limits.[415] SkyBridge also asserts that the operational limits are intended only to provide a GSO operator with a standard to determine whether its system is receiving unacceptable interference. Although Boeing states that it could provide prior verification that its system meets the operation limits, Boeing believes that advance verification of the operational limits prior to the operation of the NGSO FSS system is unnecessary. Instead, Boeing reasons that an NGSO FSS operator once operational, could be required to take appropriate action such as limiting the power to a particular spot beam or switching the frequency used on a particular beam, to eliminate any operational harmful interference.[416] DIRECTV states that waiting until after a system is operational makes it difficult to effect any necessary changes in NGSO FSS operations.[417] Virgo would support a requirement that NGSO FSS systems demonstrate their ability to meet all of the agreed validation and operational limits prior to receipt of any authorization.[418]

194. DIRECTV also requests that the Commission specify precisely the procedure to be followed if an NGSO FSS system licensed for operation in the United States is found to exceed the operational limits. DIRECTV asserts that the Commission must, at a minimum, provide for the immediate cessation of the interference. [419] SkyBridge states that the Commission's Rules already provide procedures for resolving interference complaints.[420]

195. *Decision.* For the same reasons discussed in the section above on implementation of the operational $EPFD_{down}$ limits to protect GSO FSS operations, we will also require an NGSO FSS applicant to demonstrate prior to becoming operational that it meets the operational $EPFD_{down}$ limits to protect GSO BSS operations. In addition, unlike the requirements for the operational limits with the ITU, we will require NGSO FSS applicants to demonstrate that they will meet the operational limits to protect BSS receive earth

[413] DIRECTV Supplemental Comments at 9, 13.

[414] PanAmSat Supplemental Comments at 21.

[415] SkyBridge Supplemental Comments at 16.

[416] Boeing Supplemental Comments at 5.

[417] DIRECTV Supplemental Comments at 14.

[418] Virgo Supplemental Comments at 4.

[419] DIRECTV Supplemental Comments at 14.

[420] SkyBridge Supplemental Comments at 15-16. Specifically, SkyBridge refers to 47 C.F.R. §§ 25.271-25.274 and 25.160.

stations everywhere in Alaska, or Hawaii as appropriate, all of the time.[421] Therefore, any NGSO FSS applicant that is found qualified to hold a space station authorization will be issued a conditional authorization. Specifically, as discussed in the GSO FSS section, each NGSO FSS licensee issued a conditional authorization must submit, 90 days prior to operation, technical information demonstrating compliance with the operational limits in the United States NGSO FSS applicants are fully aware of our requirements well in advance of their actual construction and operation. If the demonstration shows that the limits are not met, we will require NGSO FSS systems to apply all mitigation techniques necessary, including any changes necessary to their system design, to comply with the operational limits. In addition, if an NGSO FSS system exceeds the operational limits, it will be in violation of its obligations under the ITU Radio Regulation No. S22.2, as well as Commission rules.[422] The information that we will require NGSO FSS system licensees to submit is described in detail in the GSO FSS section and in new rule Section 25.146(b)(2).[423]

(v) Aggregate $EPFD_{down}$ Limits

196. *Proposal.* In the *NPRM*, we stated our concern about the cumulative effect of multiple NGSO FSS systems on sharing with other services, and sought comment as to how the proposed sharing criteria should be applied or adjusted to account for multiple NGSO FSS systems.[424]

197. *Comments.* DIRECTV and EchoStar state that any effective spectrum sharing between NGSO FSS systems and GSO BSS systems will require aggregate and single entry PFD limits that are well-defined and strictly enforced.[425] Further, DIRECTV suggests that if future study demonstrates that the procedure used to go from aggregate to single-entry limits must be revised, or if $N_{effective}$ changes, the single-entry $EPFD_{down}$ limits must be revised accordingly.[426] EchoStar asserts that interference from NGSO FSS systems would only be considered "acceptable" so long as it does not exceed the approved single entry and aggregate (for all NGSO FSS systems) power limits, as aggregate limits are the only way to ensure adequate protection of GSO BSS systems.[427] SkyBridge, however, finds that software validation of the aggregate levels is not appropriate, as the aggregate levels govern emissions of operational NGSO FSS systems at any

[421] Compliance of U.S.-licensed NGSO FSS systems with the operational limit to protect BSS receive earth stations outside of the United States is not relevant, as the "operational" limit only applies in Alaska or Hawaii.

[422] See ADD S22.5I in Article S22 of the Provisional Final Acts. No. S22.2 specifies that NGSO FSS systems shall not cause unacceptable interference to GSO FSS and BSS systems operating in accordance with the Radio Regulations.

[423] Specifically, we will require each NGSO FSS licensee to provide the following information: (1) the satellite/earth station resource allocation strategy, spacecraft antenna switching algorithm and the measured spacecraft antenna patterns; (2) a description of how this resource strategy/algorithm and the space craft antenna patterns are being used in the software program; (3) the software program used to verify the commitment that the operational limits and the assumption used in the structure of the computer program; (4) an identification and description of other input parameters necessary for the execution of the computer program and (5) analysis of the results of the computer simulation and the pass/fail nature of the commitment test.

[424] *NPRM* at ¶¶ 73-74.

[425] DIRECTV Reply Comments at 34, DIRECTV Supplemental Comments at 7, and EchoStar Reply Comments at 7. *See also* GE Comments at 10 and PanAmSat Comments at 14.

[426] DIRECTV Supplemental Comments at 6-7.

[427] EchoStar Reply Comments at 9-10.

given time.[428] SkyBridge supports the regulatory approach contained in example Resolution WWW.[429] Further, as the aggregate interference may include non-U.S. systems, SkyBridge asserts that compliance with aggregate levels must be assessed on an international level. Boeing states that the development of software to determine compliance with the aggregate limits serves no purpose except in the case of the fourth and subsequent co-frequency NGSO FSS systems.[430]

198. *Decision.* As we concluded in the GSO FSS section on aggregate EPFD down limits, it is necessary to ensure that the maximum aggregate interference level necessary to protect GSO BSS is not exceeded. Therefore, we will include in our rules the international consensus aggregate $EPFD_{down}$ limits referred to in No. S22.5K and contained in Table [RES COM 5/6]-1D.[431] For the same reasons discussed in the GSO FSS section on aggregate $EPFD_{down}$ limits, however, we will defer a decision on whether NGSO FSS applicants should demonstrate that that they can meet the aggregate $EPFD_{down}$ limits we adopt today, to the forthcoming rule making addressing NGSO to NGSO sharing, or to the licensing proceeding itself.

(vi) Protection of GSO BSS Telemetry, Tracking and Command

199. *Proposal.* In the *NPRM*, we stated that the proposals and questions regarding GSO FSS TT&C operations are also relevant for protection of GSO BSS TT&C operations.[432] Specifically, as we stated in the GSO FSS discussion on protection of TT&C operations, in the *NPRM* we proposed that GSO (FSS and BSS) and NGSO FSS licensees coordinate their transfer orbit operations, and that emergency TT&C operations be protected. For the protection of operational phase telemetry downlinks, we sought comment on whether the provisional limits would adequately protect telemetry downlink operations.[433]

200. *Comments.* SkyBridge asserts that the issues relating to the protection of GSO BSS TT&C operations are the same as for GSO FSS TT&C operations and therefore encourages the Commission to follow SkyBridge's proposal for GSO FSS TT&C operations for BSS TT&C operations.[434] DIRECTV indicates that it has been particularly concerned about the impact of NGSO interference on TT&C

[428] SkyBridge Supplemental Comments at 21-22.

[429] Resolution WWW is now Resolution [COM5/6](WRC-2000).

[430] Boeing Supplemental Comments at 5. Boeing bases its view on the fact that the single-entry limits were derived from the aggregate levels using a factor of 3.5.

[431] *See* new Section 25.208(j) in Appendix A. Further, Resolution [COM5/6] specifies that Administrations operating or planning to operate NGSO FSS systems take all possible steps, including modifications to their systems if necessary, to ensure that the aggregate interference into GSO networks does not exceed certain aggregate power levels. If these levels are exceeded, Resolution [COM5/6] states that the Administrations with NGSO FSS systems shall expeditiously take all necessary measures to reduce the aggregate EPFD levels to the agreed levels, or to a higher level (*i.e.*, more interfering level) that is acceptable to the affected GSO Administration.

[432] *NPRM* at ¶ 62.

[433] *Id.* at ¶¶ 29-31.

[434] SkyBridge Comments at 65.

operations.[435] DIRECTV supports the proposal that GSO and NGSO operators coordinate their transfer orbit operations, while emergency TT&C operations would be protected.[436]

201. *Decision.* As noted in the *NPRM*, the issues that are specific to the protection of GSO FSS TT&C operations are also relevant for the protection of GSO BSS TT&C operations. Therefore, we adopt the same decisions that are discussed in the section above on GSO FSS TT&C operations for the GSO BSS TT&C operations.

(vii) Other DBS Applications

202. As noted in the *NPRM*, DIRECTV is providing DBS to antennas mounted on aircraft.[437] We stated our belief that this type of mobile operation is consistent with the allocation because the DBS definition in the Commission's Rules does not limit transmissions to fixed receive earth stations.[438] Nevertheless, we requested comment on whether this type of BSS operation is consistent with the Commission's Rules and whether it is appropriate to protect this type of reception. If so, we also requested comment on what EPFD limits would be appropriate to protect aircraft mobile antennas.

203. *Comments.* SkyBridge states that it is not at all clear that this proposal is consistent with the existing allocation for the 12.2-12.7 GHz band.[439] However, SkyBridge goes on to say in its comments that it appears that airborne BSS services and NGSO FSS systems could co-exist under the presently proposed technical parameters, at this time.[440] In contrast, DIRECTV states that GSO BSS service to aircraft is encompassed within U.S. domestic and international definitions of DBS and BSS service, as transmissions to aircraft are intended for direct receipt by the general public through community reception.[441] DIRECTV states that, from its initial studies, it appears that the aircraft antenna beam shape can cause an amplification of high short term levels of interference, which could lead to service disruption.[442] However, DIRECTV does not provide additional information in its replies to confirm its initial studies on this issue, or to propose specific measures to ensure protection of this type of DBS reception.

204. *Decision.* No party internationally, or in the domestic proceeding, proposed any additional specific measures or rules to protect this type of DBS receive earth station application. Based on the text of the CPM Report, and the latest round of comments, it appears that this issue has been resolved by the $EPFD_{down}$ limits that we are adopting today. Therefore, we do not find it necessary to adopt any additional measures to protect DBS service to aircraft.

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[435] DIRECTV Comments at 15.

[436] *Id.* at 15.

[437] *NPRM* at ¶ 61. *See* DIRECTV Application Comments at 15. According to DIRECTV, these antennas tend to have wider beams in elevation than in azimuth, sometimes significantly wider.

[438] *NPRM* at ¶ 61. *See* 47 C.F.R. § 100.3.

[439] SkyBridge Comments at 63.

[440] *Id.* SkyBridge bases this assertion on the fact that the lobes of the antennas are mainly in the azimuth and elevation plane with some discrimination in other directions, and the low directivity of the antennas increases the interference from adjacent GSO satellites, increasing the system noise temperature.

[441] DIRECTV Comments at 16-17.

[442] *Id.* at 18.

b. MVDDS Sharing with DBS

205. *Background.* The major issue raised by Northpoint's petition with respect to DBS is the ability of the MVDDS to avoid causing harmful interference to DBS during periods of significant precipitation. We note that DBS receivers are digital, and the impact of interference on a digital receiver is different than on an analog receiver. In general, a picture demodulated by an analog receiver deteriorates gradually as the interfering signal level increases. This gradual degradation is reflected in the quality of the video picture on the television screen; when there is no interference there will not be any picture impairment, when some interference is present viewers will notice a gradual degradation of the picture which will get worse as the interference level increases until the picture is totally degraded. For digital receivers, the effect of interference is completely different. A picture demodulated by a digital receiver retains its quality until the desired to undesired signal ratio decreases to a level too low for the receiver demodulator to decode, at which point the picture is completely lost. This is generally referred to as the "cliff effect" of a typical digital video receiver. Because rain attenuates the DBS signal strength, its presence, if sufficiently heavy, could cause a loss of picture. Therefore, in an interference free environment, loss of picture in any given geographic area is dependent on the satellite downlink power budget and the frequency, duration, and intensity of rain in that local geographic area. During a period of significant rain, the presence of interference from a terrestrial fixed service could advance the onset of picture loss and could cause the duration of this picture loss to last longer than experienced from rain alone.

206. We also note that the main source of potential interference to a DBS receiver occurs when an MVDDS signal transmitted from a northerly direction enters the backlobe of a DBS receiver antenna, which is pointed in a southerly direction.[443] Due to this phenomenon, the interference arguments of the parties have focused on the extent to which buildings, trees, or other obstacles will shield these backlobes. In order to depict worst case deployment scenarios, our analysis assumes no shielding (*i.e.*, backlobes will be exposed to interfering signals). Thus, several potential solutions to the overall problem of interference to DBS receivers center on the reduction or elimination of backlobe interference. We address the comments and related issues below.

207. *Comments.* Northpoint states that it plans to deliver its services in the 12.2-12.7 GHz band through a series of low-cost cascading cells, each with a transmitter serving approximately 100 square miles. Northpoint states that because its technology operates in the same band as DBS and uses the same digital processing, the equipment necessary to deploy its system is commercially available. Northpoint maintains that deployment of its technology would create sufficient capacity in the 12.2-12.7 GHz band to deliver all local television signals in every market, as well as other video programming and high-speed Internet service. Northpoint states that it is widely recognized that DBS providers have limited ability to offer local programming, and that Northpoint's technology will enable such providers to offer local signals and challenge cable television in the MVPD marketplace. Northpoint further states that its ability to provide local programming can either be integrated with DBS or provided directly by Northpoint to DBS customers.[444]

208. Northpoint contends that it can offer simultaneous transmission with DBS to consumers without causing any harmful interference to reception of DBS signals. It states that its technology

[443] Specifically, a three dimensional analysis of the gain of a DBS dish antenna indicates that an MVDDS signal could come over the back and side edge of the antenna and enter directly into the offset feed, resulting in an interfering signal with minimal suppression (gain of approximately –2 dBi). *See* DIRECTV Report of January 27, 2000, at 6.

[444] Northpoint Comments at 4, 11-13.

achieves a carrier to interference (C/I) ratio of 20 dB or greater in 99.8% of its reliable service area, and that its experimental tests reveal that a C/I ratio of only 9 dB is sufficient to avoid harmful interference to DBS subscribers. Northpoint acknowledges that close to its transmitters there will be areas where the Northpoint signals would be strong enough to interfere with DBS receivers, but it contends that this impact can be minimized or mitigated. Northpoint calls this area a mitigation zone because any potential interference can be resolved through engineering techniques. Specifically, Northpoint contends that careful siting of its transmitters, antenna discrimination in the vertical plane, natural shielding and terrain blockage, and other techniques can be used to minimize the size of any potential interference areas and lessen their effect on DBS subscribers. Northpoint asserts that its technology will provide at least 99.7% service availability at the edge of its service area.[445]

209. DBS commenters oppose Northpoint's proposal, arguing that its adoption would create unacceptable interference to the incumbent DBS operations.[446] DIRECTV contends that Northpoint's claim that its technology would not interfere with DBS is unsupported. DIRECTV states that the zone around a Northpoint transmitter where the interference level is unacceptable for DBS operations occupies more than 50% of Northpoint's proposed service area, and that Northpoint's experimental progress reports demonstrate a lack of understanding of the complex technical issues involved with the effects of Northpoint's service on the provision and receipt of high-quality DBS service. Finally, DIRECTV recommends that if MVDDS is authorized in the 12.2-12.7 GHz band, each system should be treated the same as each NGSO FSS system, and therefore be permitted to have no more than a 2-3 percent impact on any DBS system's reliability.[447]

210. EchoStar states that Northpoint's experimental tests in Washington, DC reveal the occurrence of harmful interference to DBS even though the tests were designed to produce the least possible interference. EchoStar also asserts that Northpoint has improperly averaged its measurements, and argues that even if the average impact of MVDDS on DBS is not large, numerous DBS subscribers will be adversely affected. As an example of the potential adverse impact of MVDDS on its subscribers, EchoStar states that in Washington, DC subscribers who receive signals from its satellite located at 61.5° West Longitude (W.L.) could suffer increased unavailability of 84%, which would be far in excess of the 10% aggregate unavailability that is permitted to be caused by all NGSO FSS systems. EchoStar also contends that in this example the increase in its system noise temperature would be almost ten times as great as the standard criterion for acceptable interference between co-primary services.[448]

211. In reply comments, Northpoint states that many commenters opposing establishment of the MVDDS do so for competitive reasons. Northpoint contends that whether the MVDDS is offered as a supplement to DBS or as a stand-alone competitor is not the issue;[449] rather, Northpoint contends the issue is the ability of the MVDDS to reuse spectrum in the 12.2-12.7 GHz band on a terrestrial basis to deliver local television programming to DBS consumers, as well as to provide multi-channel video

[445] *Id.* at 17-18.

[446] *See, e.g.*, Satellite Broadcasting and Communications Association Comments at 2-3 and EchoStar Comments at 8-14. *See also* DIRECTV/EchoStar filing of July 25, 2000.

[447] DIRECTV *ex parte* presentation of April 8, 1999 at 5.

[448] EchoStar *ex parte* presentation of October 29, 1999 at 1-7.

[449] We note that after the *NPRM* in this proceeding was issued, Northpoint, under the name Broadwave LLC, filed approximately 70 applications for licenses under Part 101 (Fixed Microwave Services) of our rules. In these applications, Northpoint proposes to provide a multichannel video distribution and one-way Internet data service either as a supplementary service to DBS or as a competitor to DBS in this band.

programming and high-speed Internet access without causing harmful interference to other services in the band. With respect to DIRECTV's technical analysis, Northpoint asserts that the analysis is flawed both because it treats Northpoint's system as one of five NGSO FSS systems for purposes of determining whether Northpoint will cause harmful interference to DBS and because DIRECTV makes erroneous assumptions regarding Northpoint's technology.[450] Northpoint proposes that to avoid interference to a DBS system, each MVDDS system should satisfy the three following criteria: 1) average unavailability of the DBS system must not increase by more than 0.006%, or about 30 minutes per year; 2) maximum unavailability of the DBS system must not increase by more than 0.06%, or about 5 hours per year; and 3) minimum availability of the DBS system must not drop below 99.7%.[451] Subsequently, Northpoint stated that the impact on DBS subscribers from the total increase in noise from the full deployment of both its service and NGSO FSS should not exceed the larger of a 10% increase in DBS unavailability or 5 minutes of DBS unavailability per month. Further, according to Northpoint, its contribution to increased DBS unavailability will be significantly less than the contribution of NGSO FSS systems because its average C/I ratio exceeds 41.6 dB, a level at which the increase in DBS unavailability is less than 0.05%.[452]

212. The commenting parties also filed extensive analysis and data regarding MVDDS spectrum sharing with DBS in ex parte documents and through our experimental authorization process. Specifically, Northpoint performed tests on its ability to offer service without causing interference to DBS in King's Ranch, TX; Austin, TX; and Washington, DC.[453] Northpoint asserts that its tests prove that terrestrial operations could share the 12.2-12.7 GHz band without causing unacceptable interference to DBS operations. Northpoint also contends that no DBS subscriber suffered any outage, even during significant rain events, as a result of its operations in the 12.2-12.7 GHz band.[454] However, DIRECTV and EchoStar respond that Northpoint's tests were designed to depict little impact on DBS operations and actual terrestrial deployment would result in significant interference.[455] DBS proponents also argue that Northpoint's tests did result in measurable harmful interference to DBS operations because the DBS signal margins were decreased due to the interfering terrestrial signal. In response to Northpoint's tests, DIRECTV and EchoStar performed their own analysis of Northpoint's tests, filed their own measured data of Northpoint's tests, and performed rain measurements and simulated terrestrial interference outage during rain events.[456] Further, DIRECTV and EchoStar requested experimental authorization to do their own tests in Denver, CO and Washington, DC of the impact on DBS operations of a terrestrial system as proposed by Northpoint.[457] On July 25, 2000, DIRECTV and EchoStar filed the results of their tests, asserting that their replicated Northpoint-like system caused significant interference to DBS receivers

[450] Northpoint *ex parte* presentation of March 17, 2000 at 3-18.

[451] Northpoint *ex parte* presentation of February 9, 2000 at 9.

[452] *Id.* at Attachment 1, final slide.

[453] *See e.g.*, Northpoint's December 1998, Progress Report WA2XMY; Northpoint's October, 1999 Progress Report WA2XMY; Technical Annex to their Comments; and other *ex parte* filings.

[454] Northpoint *ex parte* filing of February 10, 2000 at 5.

[455] *See* DIRECTV *ex parte* filing of January 27, 2000; DIRECTV *ex parte* filing of February 3, 2000; and EchoStar *ex parte* filing of October 29, 1999.

[456] DIRECTV ex parte filing of January 27, 2000 at 25.

[457] *See* Experimental Authorization File No. 0094-EX-ST-1999.

pointed at various satellite locations.[458] DIRECTV and EchoStar also recommend further independent testing to measure possible Northpoint interference to DBS systems.[459] Northpoint responds that even though the DBS proponents designed their tests to depict a hypothetical scenario of worst case interference, they did not demonstrate that a single actual DBS customer was or could have been adversely impacted by the interference DBS proponents claimed to have been created at the Oxon Hill, MD tests.[460]

213. *Decision.* We conclude that MVDDS can operate in the 12.2-12.7 GHz band under the existing primary allocation, which requires that a Fixed Service not cause harmful interference to the co-primary BSS. Section 2.1 of our rules defines "harmful interference" as "interference which endangers the functioning of a radionavigation service or of other safety services or *seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service*....."[461] In some instances, spectrum sharing may result in services causing interference or degradation to or occasional outages of other services. Spectrum management decisions often address this issue by specifying operating requirements to minimize to the greatest extent possible the level to which such impacts occur. In this proceeding, we find that we can develop operating requirements for MVDDS that will ensure that DBS operations are not seriously degraded or subject to repeated interruptions due to MVDDS operations, thus avoiding any harmful interference to DBS.[462] As discussed in the *Further NPRM*, we intend to set technical parameters for MVDDS operations that will limit the permissible level of increased DBS service outage that may be attributable to MVDDS below any level that could be considered harmful interference. Specifically, in the *Further NPRM* we will propose that the maximum permissible increase in outage caused by an MVDDS transmitter to any DBS subscriber be a value such that the increase would generally be unnoticed by the DBS subscriber. In addition, any MVDDS transmitter that is the source of increased outages to a DBS subscriber beyond the maximum permissible level would have to correct these outages or cease operation. Thus, any impact would not seriously degrade, obstruct, or repeatedly interrupt the provision of DBS and would be evaluated in the same terms as the introduction of NGSO FSS in this frequency band.

214. We note that the ITU BSS Appendix 30 Plan targeted availability of 99.7% (unavailability of 0.3%, which is equal to about 26.3 hours, or 1578 minutes, per year) as acceptable service quality.[463] In actual domestic implementation, the availability level has been substantially exceeded in most areas of the United States, and we are confident that after introduction of the MVDDS, the availability level will remain well in excess of 99.7% for the great majority of DBS subscribers. The subscribers most susceptible to outages would be those in close proximity (1-3 kilometers) to an MVDDS transmitter, where DBS antenna backlobes may be exposed to the transmitter's signal.[464] MVDDS operations could reduce the DBS signal "margin," which is the amount by which the signal

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[458] DIRECTV and EchoStar *ex parte* filing of July 25, 2000.

[459] *Id.* at 5.

[460] Northpoint *ex parte* filing of July 31, 2000.

[461] *See* 47 C.F.R. § 2.1 (emphasis added).

[462] This is consistent with recent federal legislation that requires that no facility licensed or authorized to deliver local broadcast television signals "causes harmful interference to the primary users of that spectrum or to public safety spectrum use." *See infra* ¶ 264 (Rural Local Broadcast Signal Act).

[463] *See* DIRECTV April 11, 1994 report "Terrestrial Interference in the DBS Downlink Band" at 8.

[464] *See* example contained in Appendix I.

strength exceeds the level necessary for a subscriber to receive the DBS signal. This could lengthen an outage that would have occurred without the interfering signal being present or cause an outage if the receiver is already at the threshold without the interfering signal being present. However, in many cases the reflector dish, terrain, or various structures would shield the backlobes, thus mitigating or eliminating the interference from the MVDDS transmitter. Tests conducted in the 12.2-12.7 GHz band by Northpoint under an experimental authorization confirm that the MVDDS could operate without excessively impacting DBS subscribers.[465] Northpoint has also filed extensive technical studies to demonstrate that any impact on DBS operations would be minimal and could be mitigated using existing engineering techniques.

215. As mentioned above, DIRECTV and EchoStar conducted their own joint experimental testing to determine whether DBS subscribers would suffer significant availability losses due to new MVDDS operations, and concluded that they would. For example, DIRECTV and EchoStar contend that the increase in unavailability due to a Northpoint transmitter located in Oxon Hill, MD would range from 7.2-122.4%.[466] However, we note that throughout Northpoint's and DIRECTV/EchoStar's experimental tests, there were no reported DBS outages attributable to the tests. We would expect this result because the level of the potentially interfering terrestrial signal, as proposed by Northpoint, could result in loss-of-picture only if the DBS signal was exposed to a significant rain event sufficient to attenuate the DBS signal close to the threshold at any DBS receiver; *i.e.*, the cliff-effect, and the receiver is aligned in such a fashion to be susceptible to the interfering signal. Further, our engineering staff has thoroughly analyzed the extensive *ex parte* filings, experimental reports, and technical showings filed in the proceeding and finds that harmful interference between MVDDS and DBS operations can be avoided through engineering techniques and regulatory safeguards. We do not find that further independent testing, as suggested by DIRECTV and EchoStar, would yield any further useful information and would only further delay a decision in this proceeding. We note that neither DIRECTV nor EchoStar has identified any specific additional tests that would produce relevant new data. The arguments concerning interference have instead centered on the proper application and interpretation of test results. We find that there is an ample record to analyze the interference scenario between MVDDS and DBS operations.

216. We note that the record in this proceeding demonstrates a variety of techniques that an MVDDS operator may use to protect DBS operations from harmful interference caused by MVDDS operations. Specifically, an MVDDS operator may employ all or some of the following techniques: 1) careful site selection of their transmitters to avoid large concentrations of DBS receive antennas within 1-3 kilometers of the transmitters; 2) beam shaping through customized MVDDS antennas or tilting the beams of their transmitters to avoid DBS receive antennas; 3) adjusting the height of their transmitters; 4) reducing the power of their transmitters during periods of DBS fading due to rain; 5) more accurately pointing DBS receive antennas toward the intended satellite at their expense and with the permission of the DBS subscriber; 6) relocating DBS receive antennas at their expense and with the permission of the DBS subscriber; 7) replacing smaller DBS receive antennas with larger DBS receive antennas at their expense and with the permission of the DBS subscriber; 8) shielding DBS receive antennas from their transmitters at their expense and with the permission of the DBS subscriber; 9) employing planar DBS antennas[467] at their expense and with the permission of the DBS subscriber; and 10) using multiple

[465] Northpoint was granted an experimental license under the name Diversified Communication Engineering, Inc. in July 1997. It has conducted tests of its technology in Texas and in the Washington, DC metropolitan area to demonstrate that its proposed service can operate without causing harmful interference to incumbent DBS operations.

[466] *See* DIRECTV and EchoStar *ex parte* filing of July 25, 2000.

[467] Planar antennas are flat antennas that eliminate backlobe interference.

transmit antennas at each tower with customized beam patterns and lower power. We note, in particular, the possibility that technique 4) may have to be employed by the MVDDS operator in areas where the protection criteria is difficult to meet. In some instances this may result in the MVDDS service being briefly unavailable to some subscribers during rainy periods.

217. Accordingly, we will permit a terrestrial point-to-multipoint video and data distribution service, which we will refer to as the MVDDS, to operate under Part 101 of our Rules in the 12.2-12.7 GHz band. We find, however, that determining an appropriate increased unavailability criterion for MVDDS must take into account the inherent differences between MVDDS and NGSO FSS operations. Because an NGSO FSS system operator cannot readily tailor its operations to BSS/DBS systems in different geographic areas, WRC-2000 developed EPFD values that reflect NGSO FSS impact on BSS/DBS systems over the whole NGSO FSS service area (in this country, the entire continental United States). By contrast, an MVDDS system operator can tailor its operations to avoid causing harmful interference to BSS systems in different areas, as well as to individual DBS subscribers in the same area. Thus, while Northpoint requests that the impact of MVDDS on DBS subscribers be averaged over each MVDDS service area, we find that such averaging would be unnecessarily broad, and conclude that worst case impact to any DBS subscriber is more appropriate. Therefore, we will require each MVDDS operator to mitigate interference to DBS subscribers within an area around each MVDDS transmitter where unavailability to such subscribers would otherwise exceed acceptable levels because of MVDDS transmissions. We recognize that using a worst case unavailability criterion to any DBS subscriber may pose significant constraints on MVDDS deployment, but we conclude that we should minimize any potential decrease in availability to DBS customers located in close proximity to MVDDS transmitters. We find that such an approach is feasible because an MVDDS operator can customize its transmitter deployment. In our companion Further NPRM, we provide options and seek comment regarding the amount of additional DBS unavailability that we will permit an MVDDS system to cause.

218. Finally, we find that, similar to the protection criteria developed by WRC-2000 to permit NGSO FSS/BSS sharing, any DBS protection criteria that MVDDS systems must meet should be based on a standard model using available historical and operational data. Although we recognize that the data used in this model may not perfectly represent future DBS systems operations and that unavailability will vary from year to year due to varying precipitation, the use of a predictive model will enable both DBS and MVDDS users of the 12.2-12.7 GHz band to plan their systems around a known set of parameters. In Appendix H, we have provided a model that can be used to determine yearly and worst month DBS unavailability. This model considers precipitation amounts and the ratio of the MVDDS signal level to the DBS signal level (C/I_{limit})[468] at the DBS receiver in order to limit DBS unavailability caused by MVDDS operations to the desired level. Once this C/I_{limit} is known, it can be used to define an interference and/or mitigation contour around each tower (*i.e.*, it can be used to determine a contour line where the actual C/I is below the C/I_{limit}). This static model is similar in principle to the dynamic model used for NGSO FSS/BSS analysis. We note that the size and shape of the zone in which an MVDDS operator will have to mitigate interference will vary based on local conditions, such as rainfall rates, terrain, and the e.i.r.p. of the satellite in the direction of an earth station. We conclude that this model will minimize uncertainty between MVDDS and DBS entities in the calculation of permissible interference. Within this contour, the MVDDS operator would be responsible for ensuring that no DBS subscriber would suffer from such interference and would be responsible for shielding, relocating, or

[468] For our discussion, C is the signal level for DBS and I is the signal level of MVDDS at the DBS receiver site.

upgrading DBS antennas to ensure that MVDDS operations do not cause unavailability in excess of the permissible level.[469]

c. MVDDS Sharing with NGSO FSS Downlinks

219. *Comments.* Most NGSO FSS proponents challenge Northpoint's proposal arguing that its system would interfere with potential NGSO FSS operations or threaten the viability of their systems.[470] Specifically, NGSO FSS applicants contend that each Northpoint type transmitting tower will create an "exclusion zone" in the immediate area of the tower where NGSO FSS earth station receivers would receive interference.[471] SkyBridge maintains that while there is no reasonable concern regarding interference to Northpoint's proposed system from NGSO FSS systems because existing PFD limits are adequate, NGSO FSS systems will suffer significant interference from Northpoint operations. SkyBridge states that sharing among ubiquitous satellite earth stations and high density point-to-multipoint terrestrial operations is not possible, and that NGSO FSS service would be precluded in significant portions of any market served by Northpoint.[472]

220. Northpoint contends that its system was designed to share spectrum with DBS satellite services and that many of its sharing characteristics would also apply to sharing with NGSO FSS systems.[473] Northpoint states that its system is compatible with most of the proposed NGSO FSS systems in the 12.2-12.7 GHz band, and compatibility with all systems is achievable if modifications are made to some systems and interference avoidance techniques are used. Northpoint indicates that earth stations in the vicinity of its transmitters could be coordinated to enable ubiquitous NGSO FSS operations.[474] Northpoint contends that techniques such as terrestrial arc avoidance, satellite diversity, increased receiver antenna gain and alternative beam assignments by certain NGSO FSS systems can permit sharing between those systems and the MVDDS on a co-primary basis in all areas. Further, Northpoint contends that NGSO FSS applicants that propose highly elliptical orbit (HEO) configurations would not need to modify their systems to coexist with the MVDDS.[475]

221. Regarding interference into Northpoint's proposed receivers, Northpoint states that it can share spectrum with NGSO FSS downlink signals if the satellite PFD level is lower at low elevation angles where the terrestrial receiver antennas are pointed. Above we adopt PFD limits to protect incumbent fixed point-to-point links in the 10.7 GHz range from NGSO FSS downlinks, but Northpoint

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[469] We would accept other models for the calculation of the C/I ratio and the construction of the mitigation zone. However, these models must be agreed to by both DBS and MVDDS licensees.

[470] While Virgo originally opposed sharing spectrum with a Northpoint type operation, it later announced that its system could share with Northpoint's proposed system. *See* March 8, 2000 *ex parte* letter from David Castiel, President, Virgo; and Sophia Collier, President, Northpoint.

[471] Boeing April 28, 2000 *ex parte* presentation.

[472] SkyBridge Comments at 114-115.

[473] Specifically, Northpoint contends that directional transmission, maximum altitude transmit antenna placement, transmit beam tilting, antenna radiation discrimination, and natural shielding and terrain blocking will facilitate spectrum sharing with NGSO FSS as well as DBS operations. Northpoint Technical Annex at 34.

[474] Northpoint Comments at 17-28.

[475] Northpoint Reply Comments at i-iv.

indicates that these PFD limits are not adequate to protect MVDDS links.[476] Specifically, the PFD limits adopted above for fixed point-to-point links are –150 dB(W/m^2/4kHz) for angles of 0-5° above the horizon, whereas Northpoint requests that NGSO FSS systems meet a PFD limit of –158 dB(W/m^2/4kHz) for angles of 0-2° above the horizon and –158 + 3.33(δ-2) dB(W/m^2/4kHz) for angles of 2-5° above the horizon. Northpoint asserts that five of the eight proposed NGSO FSS systems meet its required low elevation PFD limits and that the proposed HughesLINK, HughesNET, and SkyBridge systems could meet the limits with certain modifications.[477]

222. NGSO FSS proponents argue that Northpoint's proposal that NGSO FSS systems use more restrictive PFD limits, satellite diversity, and frequency diversity would reduce the NGSO FSS system capacity. SkyBridge contends that Northpoint's proposed sharing solutions with NGSO FSS operations are "impractical" and would impose technically and economically unjustifiable burdens on NGSO FSS systems.[478] Boeing argues that spectrum sharing with terrestrial operations in the 12.2-12.7 GHz band would be inconsistent with any plan to license all or most of the NGSO FSS applicants because sharing with terrestrial transmitters would require band segmentation. Further, Boeing states that its system is not designed to avoid terrestrial interference and its point-to-multipoint structure would not permit hand-off due to terrestrial interference.[479]

223. SkyBridge indicates that its proposed system could utilize frequency and satellite diversity to avoid interference from various sources (e.g., interference from other satellites, terrestrial blockage of signals, and terrestrial signal interference). However, SkyBridge also states that it plans to deploy an expedited nationwide service with limited capabilities to initiate its service. SkyBridge argues that implementation of any of Northpoint's sharing schemes would jeopardize its expedited nationwide rollout of service.[480] Specifically, SkyBridge states that during its expedited rollout scheme, its system would have a limited number of gateway stations and satellites, thereby decreasing capacity and causing SkyBridge to have insufficient satellites to use satellite and frequency diversity to avoid terrestrial transmitters.

224. *Decision.* While Northpoint's proposed technology was designed to share spectrum with DBS operations, sharing with NGSO FSS downlinks is more complicated. Nevertheless, after reviewing the extensive filings in this proceeding, we conclude that NGSO FSS and MVDDS systems can be

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[476] Most likely, this is because MVDDS links have tighter constraints on their operations in order to protect DBS operations and because fixed point-to-point links use larger antennas with greater selectivity (higher gain).

[477] Specifically, Northpoint claims that the proposed SkyBridge, HughesLINK and HughesNET systems present a problem because their satellites transmit low to the horizon, which would increase interference to terrestrial systems, while the other 5 proposed systems have higher elevation operating angles which would limit the amount of signal energy arriving at low elevation angles. Northpoint states that the Hughes and SkyBridge systems could eliminate any potential interference to terrestrial receivers if they reduce their radiated levels towards elevation angles below 5 degrees or alternatively they could use frequency separation or increase their elevation mask. *See* Northpoint Technical Annex at 22.

[478] SkyBridge February 18, 2000 *ex parte* document at 3.

[479] Boeing February 16, 2000 *ex parte* Presentation at 6. Boeing's proposed system utilizes satellite diversity and frequency diversity to avoid interference with other satellite systems, but claims that such techniques could not be used to avoid signal blockage from terrestrial sources. Rather, Boeing uses a minimum elevation angle of 30 degrees.

[480] SkyBridge February 18, 2000 *ex parte* document at 4.

accommodated in the 12.2-12.7 GHz band if NGSO FSS systems limit their PFD toward MVDDS receivers and the two services avoid mainbeam to mainbeam interference. We acknowledge that this sharing arrangement will require careful planning and engineering, but the public will benefit from these efforts to introduce both of these new services. Further, we note that we are making available to NGSO FSS systems an additional 500 megahertz of service downlink spectrum at 11.7-12.2 GHz that will not be encumbered by MVDDS operations. We believe that current trends in spectrum usage require us to consider more complicated and creative sharing arrangements. In our companion *Further NPRM*, we discuss how this spectrum sharing can be accomplished and make specific proposals.

225. With respect to interference that may be caused by MVDDS transmitters to NGSO FSS earth stations, such interference could occur when an earth station that is in the vicinity of an MVDDS transmitter tracks the NGSO FSS satellite into view of the transmitter, or when energy from the MVDDS transmitter enters the side and back lobes of the earth station at a sufficient signal strength to cause harmful interference.[481] Nevertheless, we are confident that MVDDS transmitters will not threaten the viability of NGSO FSS downlink operations. First, as noted above, the 11.7-12.2 GHz band will also be available for downlink operations. Further, the mitigation zone in front of each MVDDS tower will be relatively small compared to the overall MVDDS coverage area.[482] While the distance at which harmful interference into NGSO FSS earth stations would occur is disputed by the parties in this proceeding, we generally find that a very small percentage of potential NGSO FSS subscribers would have any interference potential from MVDDS deployment.[483] Finally, MVDDS operators will be deploying their transmitters so as to avoid harmful interference to DBS receivers, and this will also protect NGSO FSS earth stations.[484]

226. We also note that most planned NGSO FSS systems are designed for flexible deployment because they must track multiple satellites and avoid interference from GSO satellites and blockage from tall buildings and trees. Flexible deployment could also avoid interference from nearby MVDDS transmitters. Further, many instances of backlobe interference could be eliminated through shielding. While some of the proposed NGSO FSS systems are designed with more flexibility than others, we believe that all proposed systems could be successfully deployed with minimal impact from

[481] NGSO FSS proponents call the area close to a MVDDS tower an "exclusion zone" and Northpoint calls it a "coordination area." For the purposes of this document, we will refer to this area as a mitigation zone because we haven't decided whether coordination is necessary and because potential interference to NGSO FSS earth stations could be mitigated in the area.

[482] A typical proposed Northpoint type service cell would have a diameter of about 16 km (10 miles). Each cell could have an area in front of the tower where NGSO FSS receivers from some systems could receive interference depending on the design of the system. For example, Northpoint provided a sample deployment within a 40 km (25 mile) radius of Washington, DC. That area includes 23 proposed transmitting towers, thereby creating 23 zones where NGSO FSS receivers may have to take steps to avoid interference. Sharing problems are more likely to occur in metropolitan areas where transmitters will have more limited deployment options and may be surrounded by NGSO FSS subscribers. However, we note that the great majority of each zone would not have any potential interference sharing problems because most NGSO FSS receivers would be a sufficient distance away from transmitting towers.

[483] Higher elevation NGSO FSS systems – such as those proposed by Virgo, Denali, and Boeing – would require less separation from MVDDS transmitters than LEO systems – such as those proposed by SkyBridge and Hughes – because higher elevation earth stations would not look at satellites just over the horizon.

[484] For example, an MVDDS operator will have to limit its transmitter power in order to protect DBS operations, and will likely deploy its transmitters in a manner that will minimize the number of residents in DBS remediation zones. Both of these factors will help achieve spectrum sharing with NGSO FSS earth stations.

the MVDDS because of the power limitations and deployment characteristics of the MVDDS that we have noted. However, in our companion *Further NPRM*, we will address whether coordination procedures need to be established for NGSO FSS earth stations and MVDDS transmitters to minimize possible interference in the mitigation zones.

227. Finally, band sharing between NGSO FSS earth stations and MVDDS stations will depend to some extent on where their services are marketed and systems deployed. For example, NGSO FSS earth stations may be successfully utilized in rural areas where terrestrial broadband options are not readily available. An MVDDS licensee in a rural area should be able to place its towers so as to avoid any impact on satellite earth stations.

228. Accordingly, we conclude that MVDDS and NGSO FSS can share the 12.2-12.7 GHz band on a co-primary basis. This more intensive use of the band will allow a wide variety of new services to be delivered to the public. NGSO FSS operations will enable the delivery of broadband services to anywhere in the United States, including unserved and underserved areas. MVDDS operations will deliver competition to other video distribution and data services and offer localized service that may not be possible through other services. A future NGSO FSS licensing proceeding will explore the optimal way to assign spectrum in the 12.2-12.7 GHz band to facilitate spectrum sharing between NGSO FSS systems and MVDDS systems.

3. NGSO FSS Service Uplink Bands: 14.0-14.4 GHz

229. *Current allocations.* The 14.0-14.4 GHz band is allocated on a primary basis for FSS uplinks and is heavily used by VSAT operations. In the *NPRM* we noted that the 14.0-14.2 GHz band segment is allocated on a secondary basis to Federal Government radionavigation, non-Federal Government radionavigation, and space research operations, and that there are no significant radionavigation operations in this segment other than for small handheld devices used along certain waterways under Part 90. Additionally, we noted that the 14.2-14.4 GHz band segment is allocated on a secondary basis to the mobile service, for such operations as television pickup links for Part 101 licensees. Finally, we noted that the entire 14.0-14.4 GHz band is available for secondary land mobile satellite uplink operations[485]

230. *Proposal.* In the *NPRM*, we proposed to permit NGSO FSS user terminals to share the 14.0-14.4 GHz band with incumbent GSO FSS user terminals, subject to appropriate sharing criteria.[486] We stated that such sharing appeared feasible, and that secondary operations in the band should suffer no greater impact from NGSO use than from GSO use. We requested the same information for NGSO FSS uplinks in the 14.0-14.4 GHz band as we did for such uplinks in the 12.75-13.25 GHz band, and asked commenters to address whether the WRC-97 APFD levels adequately protect GSO satellites from the aggregate power of an unlimited number of NGSO earth station transmitters.[487]

231. *Decision.* As we noted in the *NPRM*, the NGSO FSS uplink user terminal sharing scenario in the 14.0-14.4 GHz band raises issues that are similar to those regarding NGSO FSS gateway uplinks in the 12.75-13.25 and 14.4-14.5 GHz bands. For the same reasons stated in the NGSO FSS gateway uplink section, we adopt the $EPFD_{up}$ limits contained in Section 25.208(h) of our rules to protect

[485] *NPRM* at ¶ 63. WRC-97 adopted a secondary allocation for maritime-mobile and land-mobile satellite services.

[486] *Id.* at ¶ 64.

[487] *Id.* at ¶¶ 64-65.

GSO FSS satellites from NGSO FSS user terminal uplink operations in the 14.0-14.4 GHz band. We also conclude that NGSO FSS gateway earth stations may also operate in the 14.0-14.4 GHz band, since NGSO FSS gateway uplinks are also subject to the same $EPFD_{up}$ limits as NGSO FSS user terminal uplinks.

C. Other Technical Rules

1. GSO FSS Arc Avoidance

232. *Proposal.* As noted in the *NPRM*, GSO arc avoidance is one technique NGSO FSS systems may employ to facilitate sharing with GSO FSS operations. GSO arc avoidance is the method by which an NGSO satellite ceases transmissions as it passes through the straight line communication path between a GSO satellite and an earth station. Likewise, in the uplink direction, the NGSO earth station would cease transmissions to the NGSO satellite. By doing so, the NGSO system is better able to reduce the signal levels that are received by GSO FSS space and earth stations.[488] We did not propose to explicitly include a minimum arc avoidance requirement in our rules, and requested comment on this proposal.

233. *Comments.* SkyBridge and Boeing agreed with our proposal that the only mitigation requirement with respect to GSO FSS protection should be compliance with the operational $EPFD_{down}$ and operational $EPFD_{up}$ limits.[489] On the other hand, PanAmSat suggests that the Commission adopt a GSO FSS arc avoidance angle requirement, but not a "single-number," in light of the differences in NGSO FSS system design.[490] GE requests that the Commission require NGSO FSS systems to implement arc avoidance measures because arc avoidance is a useful tool in minimizing interference dangers.[491]

234. *Decision.* Consistent with our proposal in the *NPRM*, we will not adopt a specific rule that requires NGSO FSS systems to employ GSO arc avoidance. NGSO FSS operators may use various techniques, including GSO arc avoidance, to meet the $EPFD_{up}$ and $EPFD_{down}$ limits we adopt today.[492] Considering that the amount of arc avoidance needed to meet the $EPFD_{up}$ and $EPFD_{down}$ limits is entirely dependent on the NGSO system design, we find that imposing an additional GSO arc avoidance requirement would be an unnecessary constraint on the design of NGSO FSS systems.

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[488] *Id.* at ¶ 75.

[489] SkyBridge Comments at 87; Boeing argues that the critical issue is not whether arc avoidance is used, but whether NGSO FSS systems are able to avoid producing unacceptable interference into GSO FSS systems and other users of the band, and whether they can operate co-frequency with other NGSO FSS systems. Boeing Comments at 82.

[490] Reply Comments of PANAMSAT at 24; Hughes also urges the Commission to take into account the interference characteristics of the individual NGSO FSS system applications that have been filed, Reply Comments of Hughes at 4.

[491] GE Comments at 26-27. In particular, GE states that GSO arc avoidance avoids NGSO FSS satellite main beam into GSO earth station main beam interference which would be beneficial in the protection of GSO satellites operating in inclined orbits, and can also protect NGSO FSS systems from GSO systems.

[492] For example, several NGSO FSS applicants propose to employ highly elliptical orbit satellites. *See* summary of Virgo and Pentriad's applications at Appendix C of this *First R&O*. Using this constellation design, the satellites would only transmit during a small portion of their orbit (at perigee), where the satellites are separated from the geostationary arc by at least 40 degrees.

2. GSO FSS Earth Station Power Limits

235. *Proposal.* WRC-97 adopted, then subsequently suspended, FSS earth station off-axis e.i.r.p. density limits in the 12.75-13.25 GHz, 13.75-14.0 GHz and 14.0-14.5 GHz (uplink) bands.[493] In a GSO/GSO FSS sharing environment, off-axis e.i.r.p. density limits on GSO FSS earth stations minimize the interference that one GSO FSS satellite can cause into adjacent GSO FSS satellites by constraining the combined power and antenna gain transmitted in directions other than the wanted direction. These same limits on GSO FSS earth stations would provide co-frequency NGSO FSS systems with an upper bound to the level of interference that NGSO FSS systems would need to tolerate from GSO FSS systems. In the *NPRM*, we proposed to adopt the WRC-97 suspended limits for GSO FSS earth station antennas,[494] with certain modifications to reflect work performed within the ITU through October 1998.[495] We sought comment on the impact to NGSO FSS systems of not requiring these limits to be met beyond ±3° of the GSO arc. We also sought comment on the necessity of this proposal considering our existing Part 25 rules.[496]

236. *Comments.* SkyBridge urges the Commission to adopt limits that reflect the ultimate outcome of the ITU-R studies.[497] In addition, SkyBridge and Boeing propose that the limits should be applied over the entire hemisphere (*i.e.*, not just within ±3° of the GSO).[498] GE and Loral argue that existing GSO FSS earth station antennas should be grandfathered from any off-axis e.i.r.p. density requirement.[499] SkyBridge and GE suggest that the off-axis e.i.r.p. density limits should apply to NGSO FSS earth station antennas as well.

237. *Decision.* We believe that limiting the signal energy radiated by GSO FSS earth stations could be beneficial to NGSO FSS systems by placing an upper bound on the level of uplink interference that must be tolerated. However, adopting the off-axis e.i.r.p. limits proposed in the *NPRM* for within ± 3 degrees of the GSO would, in effect, allow GSO FSS earth stations to transmit at a higher level into adjacent GSO FSS satellites than is currently permitted under our rules and would be disruptive to the vast number of GSO FSS satellites and earth stations in operation. The same holds true for the off-axis e.i.r.p. density limits that were adopted by WRC-2000.[500] We conclude that the Commission's existing

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[493] These limits, contained in Section VI of Article S22 and Resolution 130, were suspended by WRC-97 due to concerns expressed by many Administrations regarding the impact on older GSO FSS earth stations of including such limits in the Radio Regulations. WRC-97 decided that more time was needed to study the suspended limits.

[494] *NPRM, p*roposed rule Section 25.204(g), Appendix A.

[495] *See Revision of Recommendation ITU-R S.524-5 Maximum Permissible Levels of Off-Axis e.i.r.p. Density From Earth Stations in GSO Networks Operating in the Fixed-Satellite Service Transmitting in the 6, 14 and 30 GHz Frequency Bands.* For example, we proposed to apply the limits only within ±3° of the geostationary orbit, and allow for TT&C operations to exceed the limits.

[496] *See e.g.*, 47 C.F.R. §§ 25.208(b), 25.209, 25.211(d), 25.212(c).

[497] SkyBridge Comments at 87 and SkyBridge Reply Comments at 72.

[498] Comments of Boeing at 82-83; SkyBridge proposes a revised rule that also includes the relaxation of the limits by "Z" dB. "Z" dB refers to some yet to be determined amount. Comments of SkyBridge at 89-90.

[499] Comments of Loral at 18; Comments of GE at 27-28.

[500] WRC-2000 adopted GSO FSS earth station off-axis e.i.r.p. density limits to be included in the Radio Regulations. These limits are 3 [three] dB more relaxed than the WRC-97 limits. *See* Article S22, Section VI of the Provisional Final Acts of WRC-2000.

Part 25 Rules are more restrictive on GSO FSS earth stations than both the limits proposed in the NPRM and the limits adopted at WRC-2000.[501] Further, the Commission's Rules limit the signal energy radiated in all off-axis pointing directions, not just within ±3° of the GSO orbit, thus alleviating SkyBridge's and Boeing's concerns. We will continue to require compliance with existing Part 25 rules for off-axis e.i.r.p. limits and not adopt the proposed rule change. In regard to SkyBridge's and GE's suggestion that limits also be placed on NGSO FSS earth station off-axis e.i.r.p. density, we believe it is more appropriate to address this issue in a forthcoming Further Notice of Proposed Rule Making, which also addresses sharing among multiple NGSO FSS systems.

3. NGSO FSS Earth Station Antenna Reference Pattern

a. NGSO FSS User Terminal Earth Station Antenna Reference Pattern

238. *Proposal.* In the *NPRM*, we proposed to require NGSO FSS user terminal antennas to meet the antenna performance requirements of Section 25.209 of our rules.[502] We also asked that commenters who disagreed with our proposal to justify why NGSO FSS systems cannot meet this requirement.

239. *Comments.* Because of the more complex antenna equipment (such as steered, paired beams) needed for NGSO FSS systems as compared to GSO FSS systems, SkyBridge believes that the proposed requirement would unnecessarily constrain NGSO FSS operations.[503] Further, SkyBridge states that the Commission's proposed standard was not developed for antennas as small as those used for its residential user terminals, which are even smaller than those used in BSS.[504] SkyBridge, therefore, proposes a more relaxed antenna reference pattern than required for FSS earth stations in Section 25.209.[505] SkyBridge also opposes the Commission's proposal that the peak gain of an individual sidelobe may not exceed the prescribed envelope.[506]

240. *Decision.* As we stated in the *NPRM*, we believe that the use of higher performance earth station antennas will maximize sharing between NGSO FSS and GSO FSS systems and use of the spectrum. However, we recognize that there are physical limitations on the amount of sidelobe suppression achievable in small earth station antennas, both GSO and NGSO. We are confident that the

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[501] There are two components to the off-axis e.i.r.p. density of an earth station--the earth station antenna performance in the sidelobe region and the RF transmitter power density. The sidelobe requirements limit the gain of the antenna in directions outside of the mainbeam (wanted direction) of the antenna. The RF transmitter power density limits the magnitude of the power radiated. *See e.g.*, 47 C.F.R. §§ 25.208(b), 25.209, 25.211(d), 25.212(c).

[502] *NPRM* at ¶ 78. In addition, we proposed to modify the rule not to allow the peak gain of an individual sidelobe of a NGSO FSS earth station to exceed the prescribed pattern.

[503] Comments of SkyBridge at 91.

[504] *Id.*

[505] Specifically, SkyBridge proposes to use an antenna gain pattern of 36- 25 log(θ) ($100\lambda/D \le \theta < 48°$); -6 ($\theta \ge 48°$). Due to the importance of the "lobe effect," SkyBridge suggests that interference analyses use the new GSO FSS earth station antenna reference pattern for the NGSO FSS user terminal as well, instead of its proposed 36-25 log (θ) pattern. The "lobe effect" that SkyBridge refers to is the way the actual sidelobe performance of an antenna is in discrete "lobes" which have peaks and valleys. Because of the motion of the NGSO FSS satellites, NGSO FSS interference will sweep through the "lobes" (peaks and valleys) and interfere with earth station antennas. Comments of SkyBridge at 91-92.

[506] Comments of SkyBridge at 92.

$EPFD_{up}$ limits we adopt today ensure protection of GSO FSS satellites from NGSO FSS earth station transmissions. Further, we are confident that the *Further NPRM* will result in an adequate sharing scenario between NGSO FSS user terminals and MVDDS operations. Therefore, while specifying an NGSO FSS user terminal antenna pattern is not needed for sharing with GSO FSS or with the MVDDS, it may be a factor to consider in sharing with other NGSO FSS systems. We do not see the need at this time to specify an NGSO FSS customer premise earth station reference antenna pattern and defer the issue for consideration, as necessary, in a separate Notice of Proposed Rule Making addressing sharing issues among NGSO FSS systems.

b. NGSO FSS Gateway Earth Station Antenna Reference Pattern

241. *Proposal.* In the *NPRM*, we proposed to apply the antenna reference pattern of 29 - 25 log(θ) to NGSO FSS gateway earth station antennas for all directions.[507] This antenna reference pattern is similar to that currently contained in Section 25.209(a)(1), except that it is tighter for certain off-axis angles, and we are not allowing the peak gain of an individual sidelobe of a NGSO FSS earth station to exceed the prescribed pattern.[508] We recognized that this antenna reference pattern is more stringent than that required by Section 25.209(a)(2) of the Commission's Rules for earth stations operating in directions other than that of the GSO FSS plane, but stated our desire to encourage the use of higher performance earth station antennas to maximize sharing. We also required any commenters who disagreed with our proposal to justify why NGSO FSS systems cannot meet this requirement.

242. *Comments.* Boeing asserts that mandating a strict pattern of 29-25 log (θ) is not justified, and that the Commission should continue to employ the antenna reference pattern in Section 25.209(a)(1) of its rules.[509] SkyBridge supports the Commission's proposed 29-25 log (θ) pattern for NGSO FSS gateway earth station antennas, stating that this pattern is representative of the performance allowed by larger antenna technology.[510] However, SkyBridge could also support Boeing's proposal (use of 25.209(a)(1) pattern), as long as it was applied in all planes.[511] Again, SkyBridge opposes the Commission's proposal that the peak gain of an individual sidelobe may not exceed the prescribed envelope as this requirement is more restrictive than allowing a percentage of the sidelobe to exceed the envelope.[512]

243. *Decision.* We believe that the use of higher performance earth station antennas will maximize inter-system sharing and efficient use of the spectrum. In addition, a higher performance antenna reference pattern will, as SkyBridge points out, facilitate sharing with other services.[513] For example, tighter patterns will reduce separation distances between gateway earth stations and terrestrial

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[507] *NPRM* at ¶ 79.

[508] *See* 47 C.F.R. § 25.209(a)(1).

[509] Comments of Boeing at 80. In their application for a NGSO FSS system, Boeing proposes use of Section 25.209 for its gateway earth station antennas. See Boeing's application at 53.

[510] Reply Comments of SkyBridge at 73-74. SkyBridge states that the antenna reference pattern of its gateway earth stations would comply with the antenna reference pattern of 29 - 25 log(θ). SkyBridge Opposition at 67.

[511] Reply Comments of SkyBridge at 74.

[512] Comments of SkyBridge at 92.

[513] *Id.*

stations for certain azimuths around the gateway station. Earth station technology for this size antenna is advanced to the stage where it can meet this requirement. Accordingly, we will require NGSO FSS gateway earth station antennas to meet the reference pattern of 29 - 25 log(θ) for all directions. We have, however, reconsidered our proposal to not allow 10% of the NGSO FSS earth station sidelobe peaks to exceed the envelope. The design considerations for both GSO and NGSO FSS earth stations are similar and we will allow the same percentage of peak sidelobe exceedance.

4. RF Safety

244. *Proposal.* In the *NPRM*, we requested comment on ways to ensure that NGSO FSS systems comply with the RF safety guidelines in our rules. We noted that some subscriber terminals might be customer installed, and requested commenters to address whether the satellite operator, service provider, or manufacturer should ensure that the radiation hazards provisions are followed. Finally, we requested comment on whether we should require appropriate labeling on those terminals to satisfy the RF safety rules.[514]

245. *Comments.* GE states that NGSO operators should generally be subject to the same environmental and RF safety guidelines as all other Commission licensees. GE proposes, however, that because NGSO antennas are movable they should be surrounded by larger safe zones to take into account their multi-directional capabilities. Finally, GE proposes that licensees of NGSO earth stations should have the responsibility of ensuring that our radio-hazard provisions are followed.[515]

246. Telesat Canada proposes that all transmitting NGSO terminals be installed in an area where access is limited by fencing or similar means; that all such terminals meet safe radiation hazard levels as specified in Part 25 of our rules; and that all such terminals have appropriate environmental clearances, municipal approvals, and radiation hazard labeling applicable to GSO terminals. Telesat Canada further recommends that all such terminals be mounted such that the minimum height of any antenna forming part of the terminal be at least two meters above the surface on which it is installed, and that if the antenna is ground mounted its minimum height be two meters above the highest point on the ground or man-made structure within 30 meters in any direction of the antenna.[516]

247. SkyBridge states that safety concerns are of the utmost importance, and that NGSO operators should be subject to the same environmental and RF safety hazard guidelines as all other Commission licensees. SkyBridge contends, however, that NGSO operators should have the same flexibility as other operators to determine how they meet these requirements, and disagrees with GE's larger safe zone proposal and Telesat Canada's required fencing and minimum height proposals. SkyBridge maintains that no party has demonstrated that any proposed NGSO terminal will exceed already prescribed limits, and that there is no need to adopt any additional rules.[517]

248. *Decision.* As an initial matter, we emphasize that all FCC-regulated transmitters, including the subscriber terminals used in FSS systems, are required to meet the applicable Commission guidelines regarding radiofrequency exposure limits.[518] It is therefore incumbent upon NGSO FSS

[514] *NPRM*, at ¶ 83.

[515] GE Comments at 30-31.

[516] Telesat Comments at 8.

[517] SkyBridge Reply Comments at 79-80.

[518] *See* Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, ET Docket No. 93-62, *Report and Order*, 11 FCC Rcd 15123, 15124, 15152 (1996); 47 C.F.R. §§ 1.1307(b)(1), 1.1310.